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MONOPOLIES IN THE ENGLISH ELECTRICAL INDUSTRIES.

AT a time when there is so great a demand for electricity, it is desirable to note the conditions which affect the supply. Therefore the question of monopolies is one of vital importance, and it behoves English manufacturers to examine closely the effect on the electrical industries. In former times, in the creating and working of an important industry, England held the premier position; but now we compete with kindred spirits on the vast resourceful Continent of America, and with our great European rival, Germany. In order, therefore, to obtain any success we must work under similar conditions. This, unfortunately, we cannot do, for in no country has the electrical industry to fight against such deleterious influences as in England. We groan under the great monopolies of the lamp and telephone. Taking the lamp question first, we will endeavour to show the result of the short-sighted policy which is being pursued. The price of an Edison lamp in England is 3s. 6d.; on the Continent a precisely similar lamp costs from 1s. 8d. to 2s., the prices being about the same in America. This being so, we cannot expect foreigners or our colonists to purchase English lamps, these not being procurable in England at easy rates. It follows with regard to electric fittings, that people buy them where they buy their lamps. Foreign firms see their advantage and are quick to utilise the opportunities. An export trade other than the sale of lamps, is the immediate outcome, and English manufacturers are unable to secure a foreign business of any dimensions. The lamp manufacturers, however, may be desirous of shaking off this responsibility by urging their inability to sell at equal rates. True it is they are crippled to a great extent by agreements, but we in England do not desire so much a reduction in prices as in the price for shipment. A lamp costs for making, something under a shilling, therefore to sell at 1s. 8d. or 2s., leaves a considerable margin of profit. At present there is little export trade, so that if lamps were exported at 1s. 8d. each, it would mean a big profit on a new development, which need not affect the home trade one iota. The future of the industry depends upon a new line of action of the lamp makers, and in the interests of all, not forgetting the shareholders, something should be determined upon. We cannot in these days of joint stock companies, appeal to the native patriotism; we must strike a more tender chord than that, *i.e.*, touch the pocket. As we have previously stated, there is a great demand for fittings for electric lighting abroad, and if England desires to secure a reasonable share of the work, she must go to the root of the thing and see where the evil lies. As we have pointed out, it lies in the baneful effects of the lamp monopoly, which is, at present, the most important factor in connection with the foreign trade.

Turning to the telephone monopoly, we see the direful effect on the home industry. The monopoly began about eight years ago; previous to that, there were numerous telephone factories established in England, and a valuable home and foreign trade was springing up. But there came upon the scene the vested interests, bringing the right to crush the growing child, a right which was exercised to the uttermost. A dog-in-the-manger policy was adopted, the United Company would permit the Consolidated Company only to make telephones, and that after a considerable period had elapsed; they would not grant licences to others willing and ready to pay any reasonable sum to enable them to continue the manufacture. It is notorious that at the time the monopolists were obliged to procure their telephonic apparatus from America. The result is, that the industry flourishes abroad assisted in the first instance by the capital of English subscribers.

From this course of procedure what advantages have been gained? In the lamp trade a few dividends from time to time have been distributed, but there is little or no reserve against the falling out of the patents, and when the date of their expiry comes they will be worthless. There

will not be then in existence any great export trade to assist the owners in their old age, and they will sink the victims of their own blindness and folly.

Viewing the course pursued by the Americans, we find it has been commercially sound. There exists in America a telephone monopoly such as ours, but the Americans look a little further ahead; the fact is grasped that though they may receive £10 in America, in order to export, greatly reduced prices must be accepted. The same instrument which cost a subscriber £10 in America is exported at 25s., thus enabling the importers to secure a large and profitable outside business. By comparing the systems adopted in the two countries we see where we have been mistaken. There is a most salutary lesson to be learnt, and the time has arrived when it should be fully mastered. The same process which reforms the lamp trade can effect a similar change with regard to the telephones. In the new patent law there exists a clause which speaks of compulsory licensing; the spirit is good, but like many other clauses its very ambiguity renders it useless. We want a law which will show clearly to monopolists in every industry that there are certain moral obligations attached to acquired patents which must be carried out. Patents should exist not only for the benefit of patentees, but also of the public.

We appeal to the electrical trade to speak out with a mighty voice on this momentous subject. The time has come for definite action, and we must endeavour to show where the monopoly is harmful. We have great confidence in British enterprise, but at the present day it must start level with its competitors, and when the goal is reached we shall not be far in the rear.

Industries on High Tension.

Industries labours under the impression that the details of the recent fatalities in America are utterly impossible, and that the outcry has been directed against the high tension system by people interested in the direct current. Be this as it may, our contemporary cannot disguise the fact that the agitation has been the means of the New York governing body taking the matter in hand, with the result already known to our readers. Had the subject been one for ridicule, is it likely that such energetic measures would have been taken? Furthermore, *Industries* makes the assertion that the accidents in America are nearly always due to badly insulated overhead direct current arc light circuits. Now this statement is directly opposed to facts, as a glance at the ELECTRICAL REVIEW for October 25th last will conclusively show, for during the last two years there have been more deaths per annum from alternating high tension currents alone, than in the nine previous years from all kinds of electrical machinery combined. Again the writer goes on: "In England we run very few overhead arc circuits, and, when we do, we insulate them properly, and put them out of reach of the public." Quite so, but even in the States the public has not greatly suffered; the poor linemen and officials of the electric light supply companies have been mainly the victims, and this is what we must strive to avoid. The admission made by Messrs. Ferranti and Ince that some of their men had received shocks, fortunately so far without fatal injury, makes one inclined to feel a little cynical over the conceit of a journalist who goes so far as to say that the rules and regulations in force here are so strict that it would be practically impossible to kill anyone but a most ingeniously suicidal customer. Is it not just as bad to make light of dangers we know to exist, as to exaggerate, and is not the best way of eliminating them, or of reducing their effects, to honestly state what they are, instead of attempting to suppress anything in connection therewith?

Insulation for High Pressure Conductors.

OUR contemporary, the *Electrician*, in criticising the Board of Trade regulations (which were first published in our pages), is again a little out of its reckoning. It is laid down that "the insulation resistance of any high pressure conductor, including joints, shall not be permitted to fall below 50 megohms per mile." In adopting such a minimum, says the *Electrician*, the Board is seeking to impose an impossible standard on electric supply companies, and the Hastings installation is quoted as at no time exceeding 3·7 megohms. Now if the Editor of our contemporary, which poses as the oracle of submarine cable operations, had more knowledge of the practical manufacture and uses of electrical conductors and less of the £ s. d. side of the question, he must have known that 50 megohms per mile is a low rather than an absurdly high figure, but the mistake into which he has fallen is apparent. Instead of bearing in mind that the conductor only is the point at issue, he has evidently included the fittings of the installation as well, and every point where a lamp, cut out, or switch is connected, forms of course a source of leakage.

Secondary Battery Plates.

IN the *Western Electrician* of the 11th inst., there appears a drawing and description of a new form of grid, or secondary battery plate, which is said to be the invention of Mr. H. G. Osburn, of Chicago. At first sight it would appear as though the plate were composed of two grids, so placed in relation to each other that the openings in one coincide with the points of intersection of the ribs in the other. Instead, however, of there being two plates the grid is cast in one piece. Some time during last year Mr. J. S. Sellon showed us some plates of his own identical in every detail with that of Mr. Osburn. Which of these gentlemen claims priority of invention?

Electric Lighting Fatalities.

THE news of two more deaths in America from electric shocks since the appearance of our last issue, is by no means calculated to reassure those in this country who hold that no danger is to be apprehended from high tension. The time is fast approaching when this momentous matter can no longer be shelved.

Railway Signals.

A NEW railroad signal system is described in the latest issue of *Modern Light and Heat*. It is, in fact, a method of communication between conductors and dispatchers of trains when disabled or detained by accidents or obstructions along the line, and also of locating the whereabouts of the mishap. There is arranged along the track a nominally closed electric circuit, having at suitable intervals signal boxes, each containing a make and break mechanism, adapted to

signal its distinguishing number, an audible or visual signal device, and an ordinary telegraph key, all the boxes being accessible to the train crews; and, further, in terminating such circuit in the train dispatcher's office, and then placing in operative conection with the circuit a Morse register and key. The boxes are all alike, except in number of makes and breaks on the wheels in the ringing-up boxes, and this is necessary in order to give a distinguishing signal over the line for each box, in order to carry out the purpose of its location. If a map be placed in the train dispatcher's office, a glance at it when a box sends in a signal will show just where that box is located. In order to simplify the matter of signalling by the train conductor, a special code of signals is proposed, which code can be printed in convenient form for the pocket, to be carried by train conductors and brakemen, and the rules and regulations of the service can also be included in the book.

Signalling through Submarine Cables.

WE hear comparatively little of what is being done in the matter of methods of signalling through submarine cables, or indeed in the matter of fast speed working over land lines, but at the same time a great deal of good work is accomplished in both directions. The Wheatstone automatic apparatus, which not many years ago was considered to be rendering excellent service when it attained a speed of 80 to 100 words a minute, has so far been improved that 600 words can now be reached in actual practice, and not simply when the instrument is worked through a plain resistance or through a looped line without an earth connection. With reference to the latter method of testing we may state that there are many who still seem ignorant of the fact that such testing is a perfect absurdity and completely misleading; it is a useful method, however, for deluding the public into the notion that they are witnessing a wonderful and convincing proof. With regard to cable working, experimental work is, we believe, being carried on by several competent inventors and with prospects of success, though any very marked improvement may not be attained; however, even a small increase in speed is valuable and worth striving after. We shall in an early number describe a form of automatic signaller devised by Mr. Timm of the Great Northern Telegraph Company, which we hear is doing good work over cables of a moderate length. Through cables under 600 miles long Mr. Timm's apparatus will do work at the rate of 47 words a minute.

Mein Herz.

A SHORT time since the Paris correspondent of the *Times* dilated at some length on an article published by M. Rochefort on the celebrated Dr. Cornelius Herz. The article is described as the most infamous attack upon a gentleman who is characterised by the *Times* writer as everything he should be. M. Blowitz—we suppose 'tis he—is evidently something of a thought reader, for at the end of his highly-spiced article we find the following:—"I was sure this unfortunate man, so shamefully insulted, would do nothing. What would have been the use? The law has made the Courts powerless, and the only thing Dr. Herz could gain by prosecuting M. Rochefort would be to be abused by his counsel and to see him acquitted, or fined 16 francs. What I foresaw has happened—Dr. Herz has taken no notice of the libel." The worthy doctor who, apparently like "Brer Rabbit" has laid low for a long time past, is used to hard knocks, and our knowledge of his somewhat chequered career would lead us to believe that he thought discretion the better part of valour in any dealings with his equally famous traducer.

Conduits.

WITHOUT criticising in any detail the plans of a conduit submitted by "One Interested" in our last issue, we would only point out that whilst he endeavours to ventilate the conduit itself, no means are provided for the ventilation of the man hole. It is here where the gas will be bound to accumulate, and it is at this point where the danger of explosion is most imminent. "One Interested" does not appear to have noticed our issue of December 27th last, where an earthenware conduit is described identical to the one to which he alludes, but earlier in date, and of which practical experience has been gained.

Underground Mains.

THERE has been a good deal more written on the subject of "underground mains" than the writer in a contemporary would imagine, but evidently it has not come under his attention. It is undoubtedly not an easy subject to write about, unless one is thoroughly conversant, not only with the history, but the experiences resulting therefrom, and before our contemporary has done with the matter it will have more reason than ever to acknowledge the difficulty. As regards early telegraphic experience there has been much more said beyond the paper referred to, which is a remarkably good one so far as it goes, but as it describes but one—the existing postal system—it is insufficient for the purpose. The same journal contains other papers on the subject. There is one thing, however, we should like to observe in connection with the article on "underground mains," that is, the evident desire to at once place in the foreground the fact that high voltage pressure must be the commercial working of the future. The voltages which are stated to be in use at the present time and not likely to be changed, are given as six in number, of which *four* are distinctly high, the fifth is as much as 500 volts, whilst the sixth class embraces only the three-wire system, being a continuous current supply at the low pressure of 220—250 volts. There is something wrong about the voltages here. Our readers, as well as ourselves, have been certainly under the impression that central station lighting, not only in this country but also abroad, had been and was still being carried out on the low pressure system of about 100 volts; it is curious that in the article mentioned no allusion whatever has been made to this, the earliest form of central station lighting. Is it really that the pressure is so "low" as not to be mentionable in a "high" class journal? Surely there must be some reason for this omission, as it is too pointed to be accidental. The use of low pressure with continuous currents, whether direct or from secondary batteries, claims a large amount of attention from town councils who are very sensitive on the question of being responsible for the lives of their citizens; consequently the high pressure system does not find much favour in their sight; on this point, however, limited liability companies have no feeling whatever, and high pressure is advocated on the score of economy.

RAILWAY SIGNALLING.

THE *Journal of the Franklin Institute* for January contains a paper on "The Evolution of Railroad Signalling," by C. Herschel Koyl, in which the author leads his audience in a very entertaining and logical manner through the requirements and needs of railway signals. Why the title should be the "evolution" of railroad signalling does not, from the nature of the paper, appear clear. We may, possibly, from the fact that what is generally recognised as railway signalling has been so sparsely adopted in America, take it that there has been very little to evolve. Railways in America have had pretty much of a wide and open field, and their system of signalling has been very much the exigencies of the moment or the sounding of a big bell bidding you to clear out of the way. The increase of population and the introduction of competitive lines has, however, to some extent obliged the adoption of methods by which the movement of trains may be brought under some control. It is with pleasure we read of the names of Saxby and Stevens, pioneers of that system of interlocking which has done so much towards the saving of life in England as well as the promotion and advancement of English railway traffic. The point, however, which will strike a reader of Mr. Koyl's paper most is why all reference to the numerous electrical aids in railway signalling should be omitted. It is true that in America they have no Board of Trade, no Act of Parliament rendering the adoption of "block signalling" compulsory, as is now the case for all passenger lines in England; but, still, we know that the telegraph does play a part and an important one in the regulation of American railway traffic, and we should have been glad to have had from Mr. Koyl's graphic pen something more in relation to the subject.

Although in its early days block signalling was regarded by a large number of railway men as absolutely an impediment to traffic, that opinion no longer exists; block signalling is now regarded as one of the chief factors in the ready disposal of a crowded traffic. What railways would do without it, or how their business could be conducted without the aid of an efficient and well organised telegraph and train reporting service, it is impossible to say! In America where railways could be formed without regard to such obstructions as existed at the time of their development in England, the need for many of those aids which have become an absolute necessity with us, may not even yet have presented itself. With us electricity not only plays its part in the operation of the regular block, but in a thousand other ways proves its utility. Thus we have the repetition of the action of the signal arm, whether it is at danger or otherwise; the registration of the light, whether it is alight or not; the interlocking of the electrical with the mechanical signals, one of the most important services yet obtained from electricity as used in connection with railway signalling, and which we hope to see yet become general; all of which duties are performed by this means, and the absence of which would, undoubtedly, at the present moment, lead to the greatest confusion and difficulty in railway working.

ELECTRIC TRACTION IN SOUTH WEST LONDON.

AS paragraphs have been going the round of the daily press to the effect that shortly several electric tramcars will be running on the South London Tramway Company's lines, we may mention that the statements made are erroneous as far as that Company is at present concerned. The company which is about to employ electric traction, to a certain extent, is the London Tramways Company, Limited, whose cars run from Westminster and Blackfriars Bridges, and from the Borough to southern districts. It is, however, only proposed primarily to run electric tramcars on the Westminster Bridge-Tooting route, but the first practical working will take place on the Clapham-Tooting line. The London Tramways Company have for a long time considered the advisability of substituting electric for horse traction, and it has been finally resolved to adopt Jarman's system, which is now being worked by the Electric Tramcar Syndicate, Limited, of 31, Lombard Street, E.C. As our readers are already aware, several trials with a Jarman electric car have been made on the Westminster Bridge-Clapham line, reports of which have previously appeared in this journal. The vehicle is an ordinary horse car transformed into an electric car by the installation of E.P.S. cells and Jarman's motor, &c., and weighs about 6½ tons without passengers. This as compared with the electric cars on the Barking line of the North Metropolitan Tramway Company is 1½ tons heavier; but in the new electric cars in course of construction the weight will be considerably diminished. The London Tramways Company have removed their cars and horses from the depôt in High Street, Clapham, to more commodious premises in the immediate neighbourhood, and have placed their old establishment at the disposal of the Electric Tramcar Syndicate. The premises are now being transformed by the latter into a central station for electric tramcars and electric lighting.

It is expected that one electric car will shortly commence running on the Clapham-Tooting line. This would have been the case a few months ago, but great difficulty has been and is still experienced in obtaining the delivery of the motors from the makers. On the starting of the first working car, others will be placed on the line in quick succession. The Tramways Company have, we understand, already obtained provisional powers for running electric tramcars, and it is believed that a rapid extension of their use will take place. The Electric Tramcar Syndicate will, in addition to running electric cars, also supply electrical energy for lighting, and, if necessary, likewise for power purposes. Mr. Jarman informs us that many names have already been handed in by those wishing to have the electric light. That this is the case in a neighbourhood which cannot be considered as a very wealthy one, and where there is not a large number of business establishments, forebodes well for the success of this branch of the undertaking. It is anticipated that the electric traction branch will also be satisfactory from a commercial point of view.

THE LUMINOUS INTENSITY OF ARC LAMPS.

(*From "Le Moniteur Industriel."*)

SOME interesting trials relative to the luminous power of arc lamps have just been carried out at the Berlin High School in accordance with certain exigencies of the civil authorities. The latter had stipulated in their forms of contract that arc lamps should give, with a current of 12 ampères, 2,000 candles, and, in some cases, 5,000 candles. Herr Elston called all the parties interested together and raised a lively discussion by affirming that the lamps at present in use did not give more than 500 candles. After this meeting the Berlin Allgemeine Elektricitäts Gesellschaft instituted a series of experiments at the electro-technical laboratory of the High School under the direction of Prof. Slaby. Dr. Wedding, in giving an account of these trials, started a sharp debate *apropos* of what was to be understood by the expression "A 2,000-candle arc lamp." Was this with or without globe? Was it under a given angle, or was it the total intensity?

The measure of luminous intensity must not be taken from any particular angle, since it varies according to the angle. If the lamp be intended to light open spaces, it is necessary to determine the different values of this intensity from the horizontal direction to the vertical direction downwards; if, on the contrary, the lamp is to light a covered space, it is as well to take

into account also the luminous rays comprised between the horizontal position and the vertical position upwards. Measurements in these different azimuths were made by the aid of mirrors. The experiments were made on differential lamps of the Siemens type in Unter den Linden. The intensity of the current was from 14 to 15 ampères, and the difference of potential from 48 to 52 volts. The place where these measurements were made being very high, the luminous intensity could be measured at different angles without having recourse to mirrors; the photometer used was one of Elster's, which is a modification of Bunsen's. The carbons seldom burnt badly, but the two sides were not so brilliant, so that two photometers had to be used, one on each side, to collate the results and take the means. The unit adopted was that of the German candle, which corresponds nearly with the decimal candle. The intermediary light chosen was that of an Albert gasburner.

The intensity following the horizontal direction was weak (without globe, total intensity = 196 candles); then it increased rapidly, and attained about 1,150 candles at 20° and a maximum of 2,014 candles at 42°; then it rapidly decreased, and at 60° the light was sensibly null. From this it results that the average luminous intensity of the surface lighted was 1,228 candles, without globe. With globes, the division of the light was quite different, as will be seen from the following table :—

	Intensity.		
	Horizontal.	Maximum.	Mean.
Globe No. 1	419	970	710
Globe No. 2	519	1093	777
Globe No. 3	497	713	590

From these figures it appears that the horizontal intensity is largely increased, and that the mean intensity is only from 40 to 53 per cent. of the intensity of the lamp without a globe. By adding a reflector, the loss due to the globe may be reduced to 32 per cent. By tracing, in the streets to be lighted, the lighting curves at different points, corresponding to a height a little less than that of the head of a man, and the lamps being placed at 8·90 metres from the ground, the light necessary to read (or 10 candles at 1 metre) is obtained for a distance from the lamp of 25 metres; the lamps should therefore be 50 metres apart. Dr. Wedding finds, also, that the actual luminous power of Siemens differential lamps with globes like those used in Berlin varies from 510 candles following the vertical direction downwards to 1,183 at an angle of 40° with the horizontal and 640 at an inclination of 5°. In short, with the most transparent globes which have been supplied and with reflectors freshly painted, the mean luminous intensity was 834 candles. Herr Elster, in his experiments on the lighting of the present streets, obtained a maximum of 640 candles; more recent experiments only gave 500 candles.

These experiments, carefully executed as they were, throw great light on the practical conditions of public lighting, and justify the disappointments which have often been experienced with arc lighting, despite the high nominal luminous intensity of 2,000 to 3,000 candles of lamps which had been announced by the makers. It is to be hoped that these trials will soon be extended to all the principal types of lamps.

THE FRENCH TELEPHONES.

FROM the 1st inst. new regulations have been in force with regard to the French telephones. Since that date the supplementary payment of 50 fr. for inter-urban communication is no longer demanded. By these new regulations all subscribers to lines joined by inter-urban circuits can correspond, from their house and with all the subscribers of the corresponding line, without having to pay a special rent for use of the urban line. They have only to pay the price attaching to each of the inter-urban circuits. This price is granted on a guarantee deposit to be made by the subscriber—a deposit which must be in accord with the importance of the communications likely to be demanded. The subscribers who wish to be admitted to the exchange of inter-urban communications must apply by unstamped letter, addressed to M. le Directeur Ingénieur des Télégraphes, 103, Rue de Grenelle. The following are the prices of inter-urban communications :—

	Francs.
Paris—Brussels	3
Paris—Lille	1.50

The duration of the conversation is fixed at five minutes.

	Francs.
Paris—Lyons	3
Paris—Marseilles	4.50
Paris—Havre	1.50
Paris—Reims	1
Paris—Rouen	1

A correspondent can only communicate for ten consecutive minutes if other correspondents be waiting their turn.

	Francs.
Paris—Versailles	0.50
Lille—Dunkerque	0.50
Lille—Cassel	0.50
Lille—Douai	0.50

The duration of this conversation is only reckoned from the time when the two correspondents are placed in communication.

	Francs.
Cassel—Dunkerque	0.50
Lyons—Marseilles...	2
Rouen—Havre	0.50
Rouen—Elbeuf	0.50
Rouen—Louviers	0.50
Elbeuf—Louviers	0.50

In cases where the line is occupied at the time a correspondent wishes to communicate, this correspondent may obtain his communication in his turn, which will allow of his estimating approximately how long he will have to wait.

Considerable irritation still exists in Paris as to the working of the telephones, those interested, of course, being the public, the State, and the Société Générale des Téléphones, which latter, by-the-bye, holds an ordinary general meeting on the 29th, the business being to hear communications from the Council of Management as to the position of the company. In the meantime, it appears that several persons have opened offices in Paris and have offered the Paris telephone subscribers their services as intermediaries between them and the Government. The latter, by the aid of its Director-General of written and verbal communications, has put the public on its guard against this form of doing business in the following note :—

"Some persons have made offers to the subscribers to the telephone of services for repairs to, or maintenance of telephone apparatus. This fact having come to the knowledge of the Administration of Posts and Telegraphs, the director, M. Coulon, has just addressed to those interested a circular to remind them that the Administration, by the terms of the new contract of subscription, takes under its charge all the expenses of the installation and maintenance of all the apparatus forming the subscriber's telephone post, without its costing the subscriber anything over and above the price of subscription. The telephone post consists of the generators of electricity, of a receiving and transmitting apparatus, and a call. The Administation also reserves to itself the installation and maintenance of the necessary apparatus of every description (extra bells, commutators, tables for several directions, &c.) which the subscriber may judge necessary for his particular wants. In order to cover at once the expenses of the installation and keeping in repair of these apparatus, an addition to the subscription, calculated at the rate of 15 per cent. on the value of the accessories set up, is collected."

In conclusion, M. Coulon informs the subscribers

that the intervention of an electrician, a stranger to the Administration, in the repair of the apparatus, is not only useless, but, further, that it is contrary to Article 7 of the contract, which says that the subscriber must not dismount or displace his wires, apparatus, and accessories.

ON THE RESPECTIVE MERITS OF CONTINUOUS AND ALTERNATING CURRENTS.

(*Concluded from page* 47.)

The dangers from primary conductors in the central station are not greater than those connected with other industries.

All danger outside the factory may be avoided by putting a solid covering on the cables, or by placing them in tubes, which, moreover, will put them beyond the risk of possible accident when the roads are broken up for repairs to water or gas pipes.

2. Alternating current dynamos give a smaller return than the continuous current dynamos. The best alternating current dynamos give from 75 to 85 per cent. of effective power; continuous current dynamos give 90 to 95 per cent.

3. The alternating current machines are not easily coupled upon the same circuit. A great many papers have been written upon this subject.

It is always easy to set up the continuous current machines in parallel; this cannot be done with the alternating current machines except when their movement is completely synchronic; that is to say, not merely when there is the same number of alternations of current, but also when there is harmony in their phase.

The author of the article in the *Elecktrotechnisches Echo* cites Mordey's opinion upon the possibility, affirmed by Kapp, of coupling alternating current dynamos in parallel when these dynamos have a considerable coefficient of self-induction, and the impossibility of obtaining this result with machines which have no iron in the armature.

Mr. Mordey observes that dynamos with great self-induction make very bad regulators. He quotes the opinion of Forbes, according to which the introduction of iron in the armature diminishes the effective power, and renders the maintenance of equality of tension for different loads excessively difficult.

Mr. Mordey reminds us that Ferranti only makes use of big machines, each one working upon its own conducting wire. Mr. Mordey claims to have succeeded in making two of his new dynamos work without iron. It is true that Kapp has shown that these machines possess a fairly considerable coefficient of self-induction, and that, as M. Rühlman has pointed out, Mordey's experiments, having been made with two machines of identical type and dimensions, are not conclusive.

However that may be, it is now possible to work alternating current machines regularly in parallel series, as has been shown at the central station in Rome; nevertheless, this result has, so far, not been obtained except by diminishing the current produced by the dynamos, especially when the load is light, and except by making the maintenance of constancy in the tension more difficult.

4. The transformation of energy in the transformers involves a considerable loss. It increases the uncertainty and the dangers in the working.

The advocates of alternating currents say that these losses are insignificant; the adversaries of the system affirm that they are so great as to neutralise all the advantages of alternating currents for moderate distances.

Now, the transformer ought always to be calculated, not merely for the intensity for which the conductor has been calculated (two-thirds of the lamps), but always for the entire number of lamps attached to its secondary conductor, and even for a small reserve. It follows that even whilst the conductor has its full load, the transformer has only two-thirds of its maximum load; the conductor has only its full load for a very short space of time, and this load is soon diminished by half and more.

The transformer, then, is working under conditions which are becoming more and more unfavourable, and its loss in a day's work may amount to 50 per cent., and even more.

The author adds: "it is not merely whilst its secondary conductor is closed that the transformer's consumption of energy is going on; but the continual demagnetisation of its iron calls for force even when the secondary circuit is open."

The losses would be slightly less were it possible to instal smaller transformers for summer than for winter use; but in practice this is, of course, not possible.

In order to minimise these losses in the transformers when the load is small, it has often been proposed to proceed in such a way that the transformers shall cut themselves out of the circuit when the load is light; this, however, is hardly practicable.

One method of doing so would be to instal several small, instead of one large transformer. One of these would be always in circuit; the others would only be so accordingly as they became necessary. But this would increase the price of the installation and the work would be carried on on a principle the reverse of economical, since the small transformers give much less results than the large ones. We might also connect together the conductors of several transformers. This disposition would have, moreover, this great advantage: that should one transformer come to a standstill, the others would take up its work; the reserves would not need to be so large and the differences of tension would be better compensated for. It would, however, supposing the principle to be carried out thoroughly, lessen the cost of the conducting wire to such a point that, having regard to the high price of transformers, there would cease to be any economy of conducting material as compared with the continuous current system.

5. The alternating current wears out the lamps more quickly.

Independently of the difficulty of maintaining evenness of tension in continuous current machines as they are now, especially whilst a second machine is being placed in circuit, variations of current will occur in the distributary conductors of a central station that employs alternating currents much more easily than in those of a central station with continuous currents; because in the latter it is exceptional for the distributary conductors or the secondary conductors to be in communication with the network, and consequently impossible for variations to take place in the other conductors.

The effect of these variations is the speedier wearing out of the incandescent lamps. However, observations made at the central station of Milan, which works with the alternating and the continuous currents as well, have shown that sometimes the lamps last as long in both systems; it must in truth be observed that this central station is bound to replace all lamps destroyed by the current, and that, consequently, the regulating is performed with the utmost care.

6. Arc lamps with alternating currents have less of effective force, and in many establishments their noiseness is a bar to their use.

Their production of light is much less in proportion to the energy consumed than with the continuous current. That is owing to the fact that the positive carbon of the continuous current lamps is in the form of a crater, the interior surface of which becomes incandescent, the result being not merely that for an even consumption of energy there is a greater development of light, but also that the light is shed where it is intended to be.

The Frankfort Commission observes that this difference is more noticeable in street lighting than in the lighting of enclosed spaces where there are walls and ceilings to reflect the light.

According to M. Kittler 16 ampères are necessary in order to give an even brilliancy to the lamp with an alternating current, whereas it needs only 10 to 12 with a continuous current.

According to the *Centralblatt für Elektrotechnik* the light which is furnished by the alternating current is 33 per cent. weaker.

According to Miller the alternating current lamp only gives 60 per cent. of the spherical luminous intensity of a continuous current lamp, the consumption of energy being, be it noted, equal in both cases.

M. Geist makes one important observation—viz., that as an alternating current lamp casts the light horizontally, it is more suitable for the lighting of enclosed spaces where it is not necessary to place it so very high, and consequently makes the service easier for the *employés*.

Messrs. Siemens and Halske insist that for an angle of 45°, at which it is necessary to project the light, the relation between the quantities of light is as 3 to 5, according to whether we employ an alternating or continuous current.

It must not be forgotten that we owe to this firm the invention of differential lamps for solving the problem of the electric light's division.

MM. Kittler, Mordey, Siemens and Halske urge that the whistling and humming of the alternating current lamps are drawbacks to their employment in house interiors.

The author of the article in the *Echo* points out that in many alternating current factories the lighting is by means of continuous current arc lamps.

7. Good, really practical motors, worked by alternating currents, are unknown up to the present.

The only means of making the lucrative working of central factories a certainty, as well during the day and during the summer, is (apart from the accumulators for charging) to supply power through the medium of electric motors.

It is in their application to this that transformers are called upon to prove their aptitude for bringing electricity long distances, and thus making possible the use of natural forces for the profit of humanity. Yet this office has been closed to alternating currents so far, because, in addition to occasioning great losses, it has never been possible by using them to attain the regularity that is necessary in the working of electric motors. The best results yet obtained have been furnished by synchronic motors; that is to say, motors working at a certain rate of speed exactly corresponding to the number of alternations made by the current in the dynamo. These motors have, nevertheless, three great drawbacks; in the first place, they need to be set going by some other means, whatever it may be; secondly, the speed can not be altered at will, yet, that they should be capable of being so, is necessary for a great many purposes; thirdly, they stand still the instant they become surcharged, and this necessitates their being set going again.

The employment of small synchronic motors would be impracticable, as they would require a rotatory speed that would be inadmissible.

Apart from these drawbacks, alternating current motors are uncertain in their working. This is why continuous currents are employed when a motor has to be put in action, even in those factories which are worked with alternating currents.

We are aware that the Mordey motor is an alternating current synchronic motor. Of the nature of the motor invented by Ganz & Cie., who claim to have solved the problem, we know nothing.

In any case, the author infers, the alternating current motor has one great superiority over the other—viz., its capacity to work with a higher tension. This is specially interesting in what concerns conductors intended for the transmission of forces to great distances.

8. It is impossible to accumulate the energy of alternating currents.

Evidently it is not possible to accumulate alternative currents directly.

It has been proposed to do so indirectly, by putting a continuous current motor in action by means of an alternating current motor, and accumulating the current of the former; but, given the principal functions of accumulators, this method would be illusory. The result is, that, with an alternating current, dynamos only could suffice for the service during the day and towards the end of the night; but even then this mode of working, already so expensive in itself, becomes still more costly in a system of alternating currents with transformers, the more so, because with the alternating current it is impossible, as yet, to foresee with certainty whether the electric motors ought to increase the production during the day.

9. The alternating current is not so easy to measure as the other.

This objection no longer holds good in view of the excellent working of some of the new apparatus.

10. The incessant reversal of the current wears out the insulating envelope, and some of the advantage which might have been derived from the copper section of the conductors is lost.

Regarding this, Mr. Brown makes the following observations: "each conductor forms in some manner a large Leyden jar, in which the copper represents the interior sheathing, whilst the insulating envelope represents the glass, and the sheathing of the cable, with that which surrounds it, represents the outer sheathing. The exterior will always discharge itself simultaneously with the interior, because it is in contact with the earth. These continual discharges are invariably accompanied by a molecular disturbance which ends by scattering and destroying the insulating envelope. Beyond this, the discharging of this colossal Leyden jar involves a loss of energy. The discharge, moreover, will be accomplished with greater difficulty and more slowly on the surface of the conductor than in the interior, because the electricity is maintained on the surface by the reverse electricity of the sheathing The copper surface will therefore present much greater resistance to an alternating current than an equal section in the interior of the conductor. In other words, when the alternating current is employed, the copper section is not so completely utilised as it would be with the continuous current, with which, moreover, no energy is consumed in discharging the sheathing and all that which surrounds it.

The author here concludes his arguments in favour of continuous currents; our readers will have noticed that he has been careful to make the most of the demerits of alternating currents, and, according to him, the merits of that system are, after all, very slight indeed.

It is very evident that he is not altogether wrong, and that in many cases the use of the continuous current is to be preferred. It cannot be denied, however, that the great extension of the alternating current system seems to indicate that it has the greater future before it. The attempts which are daily being made to improve the general effect in the application of these currents must, we feel perfectly certain, be crowned with success sooner or later.

One of the serious defects of alternating currents is the impossibility of storing up the motor energy during the day. Now, we have here an arrangement proposed by an American inventor, which at first sight seems simple enough.

The alternating current dynamo is provided with three collectors corresponding to three conductors; one of the two furthest conductors carries the positive currents, the other the negative currents, and the central conductor combines the two.

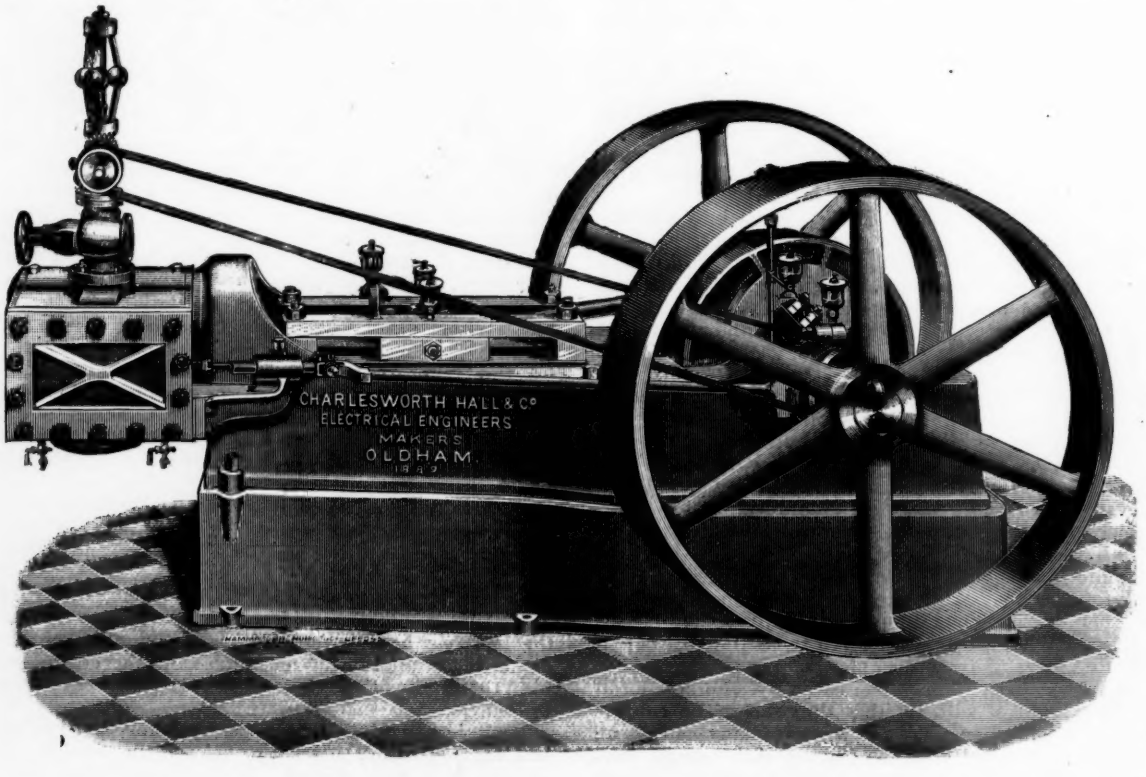
This will allow of the accumulators being charged, as in the continuous current, and one of the last obstacles to the use of alternating currents is got rid of.

The future alone must decide between the two systems; at present, we believe the alternating currents have the greatest vogue in central stations, in America especially.

ENGINES FOR ELECTRIC LIGHTING.

OUR illustration shows a horizontal engine of a type lately brought out by Messrs. Charlesworth, Hall and Co., electrical engineers of the Richmond Hill Iron Works, Oldham. These engines are intended principally for driving electric light machinery, they are of massive construction, and having very stiff shafts and large bearings are capable of making long continuous runs. The cylinders have piston valves, lapped and ground, and in order to get a good opening to steam they are double ported.

The crank-shafts are of forged steel and, as mentioned above, are exceptionally stiff, the crank webs are circular and have cast iron balancing discs shrunk on to them. The slides are of the four-bar type, the bottom slides being planed on the bed itself and in order to take up wear the slide block has an adjustable shoe. Wear on top can be taken up by letting down the top bars. The slide surfaces are very large and consequently adjustment will very seldom be necessary.



The piston rod is of hard steel, fixed by a cone and nut into the piston and cottered into the slide block. The valve rod is fixed permanently into the valve, and has an adjustable joint into the guide so that the valve can be adjusted without removing the valve chest covers.

The connecting rod is adjustable at both ends. Pickering governors are fitted on the valve chest inlet; automatic or hand expansion gear can, however, be fitted if preferred.

The makers of these engines have paid careful attention to the question of lubrication, so that all parts of the machine can be lubricated whilst running.

In order to balance the strain on the crank-shaft the engines have been fitted with two flywheels, as will be seen in our illustration. They are finished throughout in the best manner, and the best quality of material has been used everywhere. These engines present an excellent appearance and run with the greatest steadiness, and are giving much satisfaction in regular work at the several places where Messrs. Charlesworth, Hall and Co. have erected them.

AGRICULTURAL HALL EXHIBITION.

AN International Exhibition of machinery, manufactures, appliances, and inventions incidental to engineers, electricians, builders, and ironmongers will be held in the Royal Agricultural Hall, Islington, N., from the 17th to the 29th March next. This will be the second Exhibition of the kind, the first having taken place in the same hall in November, 1888; but at that time very little prominence was given to the engineering and electrical sections. This year, however, the scope of these two sections will be considerably extended. The exhibits will, among other articles, comprise those representative of lighting and heating, smoke abatement and ventilation, sanitary engineering, electricity in all its branches, agricultural implements, constructive ironwork, machinery of all kinds in motion, civil engineering, hydraulics and pneumatics, telephone apparatus, marine and submarine engineering, and engineering in all its branches. A large number of invitation tickets has already been sent out, and the manager of the Exhibition will forward admission tickets to all civil, marine, submarine, electrical, mining and mechanical engineers in the various towns, and from which excursion trains will be run. During the holding of the Exhibition conferences will be held and lectures delivered, particulars of which will shortly be announced. Arrangements have already been made with several large engineering firms to have important exhibits of machinery in motion, and we are informed that many of the leading firms in the country have decided to participate in this Exhibition, which promises to be very successful.

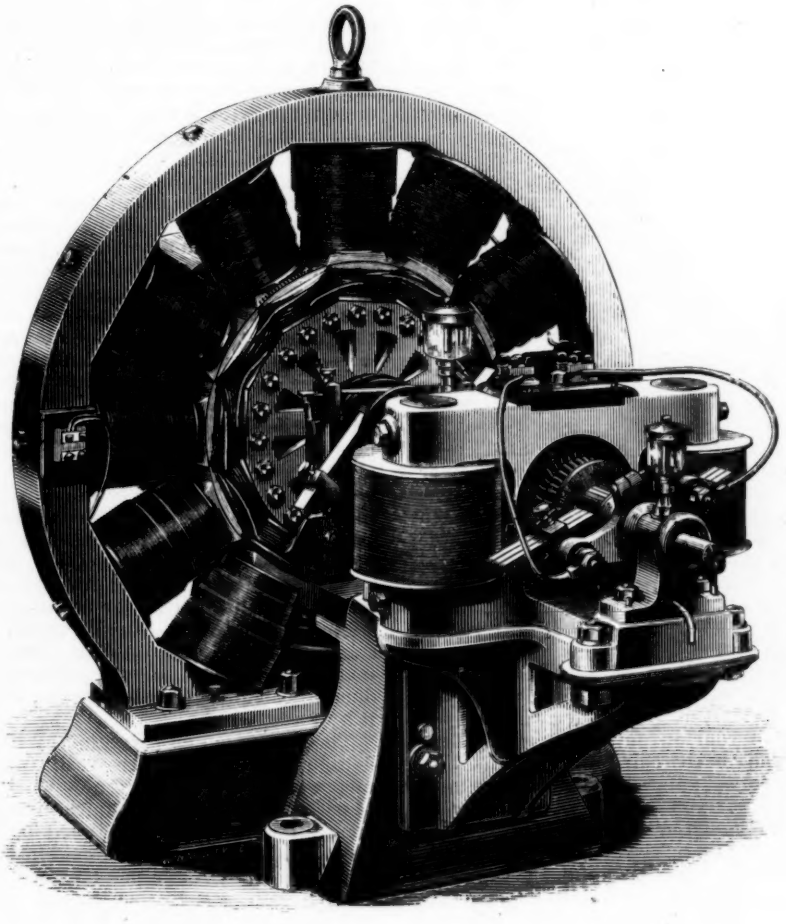
At the first Exhibition the hall was lighted with gas, but this being considered unsatisfactory, it is proposed to illuminate the building throughout with electricity. A suggestion has already been brought forward that a permanent electric light installation should be put up; but this proposal will not be adopted at present, owing to the fact that those having control over the Agricultural Hall are not disposed to entertain the project. The promoters of the International Exhibition were primarily inclined to

throw open the electric lighting to competition, and to divide the lighting into three sections, for which prizes of £20, £30 and £50 were to be given. It has, however, now been decided to abandon this scheme and to award one prize of £100 for the electric lighting of the whole building during the holding of the Exhibition. The competition will shortly be opened, and a jury composed of impartial persons will decide the matter. It is very probable that the jury will be appointed by the Electrical Section of the London Chamber of Commerce, which Section is about to be consulted on the subject. It may be well to mention that steam or other power will be provided gratuitously, so that the only work for the successful competitor will be to instal the dynamo or dynamos, effect the wiring, and keep an attendant on the spot for the time being. The sum of £100 is certainly not very large, but the installation will be an excellent advertisement to the undertaker, especially as the Exhibition will be visited by many thousand persons. Any further information, including applications for space, which must be made before the 24th February, may be obtained of Mr. Harry Etherington, manager; or Mr. Alf. Blackman, secretary, at the offices, 43, New Oxford Street, London, W.C.

ALTERNATE CURRENT MACHINE.

MESSRS. MATHER AND PLATT, of the Salford Ironworks, Manchester, are now manufacturing an alternate current dynamo which embodies several new features, and has given very satisfactory results in practice. As is the case with most alternate current machines, in which the armature contains iron cores, the armature revolves and the magnets are fixed. The magnets are wrought iron, and are arranged round the armature, exterior to it, and are attached to a massive cast iron ring, which forms the yoke connecting the limbs. The attachment is so arranged that any of the magnet cores can be removed without disturbing the remainder, or taking out the armature. The armature is constructed of two plates or discs keyed on to the shaft, between which the armature cores are held by bolts, so that, as with the magnets, any section of the armature can be removed without disturbing the remainder. Apertures in the discs allow free ventilation in the interior of the armature cores.

The magnets are excited by a Mather and Platt's "Manchester" dynamo, which is carried on a bracket bolted to the bedplate of the alternator, the armature



shafts being coupled direct. The whole arrangemen is exceedingly compact, occupying little floor space.

The machines are manufactured under the patents of Dr. John Hopkinson and Dr. Edward Hopkinson, and are made in several standard sizes up to 100 Board of Trade units.

For working with transformers, they are constructed either for 1,000 or 2,000 volts, and from 8,000 to 12,000 alternations per minute, or with a "periodicity" of from 66 to 100. The machines can be run in parallel perfectly, and may be thrown into parallel working without the least danger, even when there is considerable difference between the electromotive forces at the terminals, or the machines are running at different speeds.

The machine illustrated is for an output of 1,000 volts and 30 ampères, at 800 revolutions per minute. The armature resistance is 0·55 ohms, and the resistance of

the magnets 2 ohms. When working with full load, the current through the magnet coils is 21 ampères, showing an electrical efficiency of over 95 per cent.

Messrs. Mather and Platt have already constructed several of these machines for central station work, and have a number now in course of construction.

PATENTS.

THE other day appeared an advertisement offering for sale seven British patents of the late New Telephone Company. We believe when this undertaking started it bought from Dr. S. P. Thompson nearer a dozen (the rest may have been allowed to lapse), the purchase money being £5,000 worth of shares, with the agreement that one-third of any further issue of capital should go to him, as also £4,000 in cash out of the first profits applicable to dividend. It is hard on these figures to fix the exact amount of value set upon these patents by the directors who acquired them, but we fear it was more than the liquidator will now obtain.

The United Telephone Company makes it a rule not to sell, but only to let. Many persons would, especially on short private wires, prefer to have their own instruments, and, we believe, a considerable number were sold by Dr. Thompson's company. But the big boy swooped on the little one, who had the alternative of shelling out his pocket money in defence of his rights (if any) or of caving in. In the exercise of his discretion he sank his valour, whether wisely or not it is not our object to discuss now; but this we know, that at the time it was freely declared by some having intimate knowledge of the subject, and whose opinions are entitled to respect, that it was not a certainty that an action for infringement would have resulted in a victory for the plaintiffs. Seeing that the receiver patent has eleven months only to run, and the transmitter but eighteen, the market would soon have been open to them, could they have held out. The collapse is ancient history, it happened nearly a year ago; and we should not exhume its memory, but for the moral. The moral "lies in its application." If you are thinking of taking out a patent, most certainly if in the direction of interests owned by any monied combination, look around carefully, and be sure you have an odd fifteen thousand or so lying handy for which you have no particular use. It doesn't matter whether you are perfectly positive your invention is an absolute novelty, or that you have coincident opinions of good experts and counsel; if you haven't that loose cash you are no good. If you deposit your savings at the Patent Office it is much more than probable that you will not receive money's worth back; but you may get harassed days, sleepless nights and ruin. A provisional has ere now been the first step in the downward course. Take it, and if it be valuable expect an injunction restraining manufacture, or at least an order to keep an account. You then go to your solicitor, he to counsel, and then there are consultations. Next comes the trial, and the legal filament splitting. If you are the victor you are dragged to the Court of Appeal and afterwards bailed, more unwillingly than more celebrated men, to the House of Lords.

There are two sides to almost every question, and you will find scientific men of repute giving evidence against your cause, till you say deliberately what David said in his haste, and agree with the remark attributed to a counsel in a case, the small print of which in our columns doubtless tried your eyes and patience, that there are three categories of those who say the thing which is not.

The most vicious critics of our Patent Office never accused it of needlessly stifling inventive genius by a too strict investigation or exhaustive search for a similar precedent idea. It does not capriciously reject a large percentage of provisionals, but with a broad liberality accepts them and the fees: giving the courts a chance to settle disputes. For though it is true an application may be opposed, unless you can upset every claim you simply make a bad patent a good one by pointing out what should be disclaimed. We were once surprised, however, to find a blue book bearing date in the past decade wherein an inventor living at a remote spot in the Western Hemisphere describes an electro-magnet, and to see printed on it the ominous words—"application refused." This was hard on him, if he were rich. What a harvest of royalties he might have reaped! We have often wondered that no one has been smart enough to patent a horse and cart, and go for infringers. He would only have to threaten users with the House of Lords to keep half the solicitors in London drawing licenses.

It does not pay to invent. This is a free country, and he who makes free with the inventions of others gets on best. Read up a subject. Combine the claims of all the Blue Books thereon, and slightly alter the drawings. If you are extravagant, pay a trusting being with a capacity to make a few experiments, and insert his suggestions. A few paid articles in obscure newspapers, and you are in a fair way to be handed down to posterity with Watts, Stephenson and Faraday. Sell your patent to a combination with plenty of underwritten capital for forty thousand pounds or more, if you can get it.

The inventor has given place to the patentee. Men don't burn their chair legs now, because they can't buy fuel. Laugh at the small fry who are weak enough to have original ideas. Use them. Hound then down. Prosecute them for infringement. So shall you be a man of the age, gain riches and honour, and die a chairman or a managing director at the least. Lucre is the only God and Bunkum is his prophet. The pale inventor is as obsolete as the dodo. Once, and once only, did we see the ideal—the inventor of romance—tall, oldish, slightly bent, with long grey locks, pinched face and distracted air. He had seedy garments, which although nearly destitute of colour, looked as if they were unaccustomed to broad day light. He stalked into the sale office in Cursitor Street, and said he wanted to take out a patent. The young man asked him which, but he did not see the joke. He was advised to go to an agent, but objected that it was his wish to do it himself, as he understood the process was simplified. He left after fruitless efforts to understand where to go and what to do. We cherish this memory. We shall never see him again. The kingdom of patents suffereth violence, and the violent take it by force.

The protection of inventions is a glorious thing, no doubt; and, if they were really protected, all honest men would rejoice. We know what a large proportion of patents are thrown out in Germany, and cases where applications have been rejected by the United States Patent Office, after having obtained the great seal in London, because of a prior patent granted here. No one, in selling a British patent, was ever known to guarantee its validity. "Why is this thus?" Is our Patent Office in advance of the age or behind it? We can establish the title to land, no one would buy it unless we could, but anyone can jump the claim of an inventor if he is off his guard.

The multitude of patents registered under the last Act must produce, one would think, fees sufficient to provide intelligent searchers. A patent only lasts fourteen years at the most, excepting in specially prolonged cases, and then the world at large has the benefit of the ideas it contains gratis. The inventor pays a fee for what is called protection, but is not; it does not seem to be the fault of an Act of Parliament, but of those to whom is entrusted the carrying it out, unless they be too few and overworked. Reform is needed somewhere, not in law, but in practice. A procession of inventors on strike, with blue calico banners, would be affecting and effective, and might be effectual. We are open to receive any suggestion which would lead in the direction of a consummation so devoutly to be wished as a patent, which, in no court of law, could be successfully assailed.

THE CONNECTION OF LIGHTNING RODS TO GAS AND WATER PIPES.

Reported by A. FISCHER, of Berlin.

AT the last year's congress of the association of gas and water officials it was resolved to appoint a commission for the consideration of the above question. This committee was to add to its number other experts, and to consult with the Electrotechnical Association and the Union of German Architects and Engineers. The commissioners selected have thoroughly investigated the subject, both by correspondence and by word of mouth at a meeting which took place on May 8th, last year, in Berlin. At this conference, H. H. Fischer, Hasse, Kummel, Reissner and Salzenberg were present, whilst Hegener and Dr. Schilling were prevented from attending.

Delegates of the Electrotechnical Association, and of the Union of German Architects and Engineers have also discussed the subject in a joint session, held in Berlin, on May 10th.

At the deliberations of the Lightning Commission of the Association of Gas and Water Officials, it was agreed that no discussion should take place on the theoretical, scientific aspect of the question. The most eminent physicists and electricians have decided, that even the best lightning-rods are not absolutely capable of preventing the lightning from springing off if large metallic masses exist even at some distance from them, which have a better earth connection than the lightning-rod. This is especially the case with gas and water-pipes which generally extend up into the highest storeys of houses.

But if we disregard the desire—theoretically, quite justifiable—to obviate this danger by connecting the lightning rods to the gas and water pipes, the technical and practical phase of the question presents difficulties which may make us hesitate. Without disputing the possibility of danger, in certain cases, from the lightning springing off, gas and water officials are not unanimous whether the danger is so great as to justify the demand whether the proposed connection will in all cases afford absolute protection, and if damage may not ensue to the pipes, and if the right of the gas and waterworks to dispose of their property would not be interfered with in a serious and unjustifiable manner. (It would appear that in Germany gas and water pipes in the interior of houses are the property of the respective companies.)

The following points were examined by the Commission :—

1. *The Necessity of this Connection, according to Statistical Data.*

The Commission was not in possession of definite statistical data as to increased danger from lightning due to the gas and water pipes in towns.

The publications of the sub-committee of the Electrotechnical Association, and other authorities, furnish merely data on single interesting cases of damage from lightning. The report of Dr. Voller on observations in Hamburg, according to which the majority of lightning strokes were carried off harmlessly by the pipes forms likewise no valid basis for any conclusion as to the increase of the danger. The conditions under which the lightning fell are not sufficiently known, and there is no comparison with former seasons. No generally valid proof of the danger has hitherto been supplied by experience. The conjecture of Prof. Kohlrausch that at present half the lightning strokes are carried off harmlessly and imperceptibly by the system of pipes will scarcely justify a conclusion as to the necessity of a connection.

As to the extent of the danger of damage to the pipes by lightning, it can merely be stated that cases of such damage are rare, especially instances of the lightning glancing off from a conductor of moderately efficient character.

Complaints of such danger on the part of gas and water companies have, to our knowledge, not been hitherto raised. It appears that, as far as experience hitherto shows, neither as regards danger to the buildings nor to the piping itself, nor to a suspected increase of danger on account of gas and waterworks is there any absolute necessity for the connection of the pipes with the lightning rods.

2. *The Safety for Buildings and Pipes effected by the Connection.*

If, according to the above, the gas and water companies should facilitate the proposed connection in order to remove a possibly existing danger, it was especially binding upon the Commission to determine whether the connection of the lightning rods would fulfil the expectations entertained as to the safety of the buildings and the pipes.

It is to be borne in mind that gas and water pipes are not laid down with any reference to the conduction of lightning. This, indeed, can scarcely be expected if in the opinion of the tradesmen employed some other method of connecting the distinct pieces of tubing would be more suitable for the immediate purpose of a gas or a water-supply. In the common way of connecting the pipes in houses by means of hemp and solder, the electric conductivity of the pipes may possibly be equal or even superior to that of ordinary lightning-rods. Yet, according to the experiments of Prof. Kohlrausch this is by no means invariably the case, and it can not be guaranteed for all pipes or for a permanency.

Phenomena similar to those occurring in lightning-conductors giving rise to dangers for adjacent conductors are not in all cases impossible with a connection. They become the more dangerous when they occur inside inhabited rooms.

The small amount of resistance does not necessarily ensure the safe escape of currents of such strengths as occur in lightning, and which have been estimated by Prof. Kohlrausch at above 50,000 ampères. In all connections of a conducting pipe the material must have a section sufficient to prevent an excessive heating or destruction. This cannot, however, be everywhere taken for granted. Certain kinds of connections effected by means of wood, asphalt, cement, caoutchouc, red lead or putty would absolutely prohibit a connection. A connection of the piping to lightning rods cannot be safely and efficiently effected except the length of piping concerned is permanently and safely connected with the system of mains.

There exists in many buildings gas-piping which is not yet connected with the street mains, but is merely placed for future use if required, and which, at least, is disconnected. A junction of the lightning rod, to such piping would, under any circumstances be dangerous, as there is no security that any interruption would be spanned over with a sufficient piece of metal.

Junctions should also be excluded with pipes which might possibly be damaged by the current, *e.g.*, lead and tin piping of the diameter commonly met with in practice, or brass and iron tubes of an insufficient section.

All these cases are the more serious, for the less efficient is the earth-connection of the lightning rod. They would be simply dangerous, if piping containing such a breach formed the only conduction for a lightning rod, without earth plate or with one that was inadequate.

The Commission adheres, therefore, to the view taken up of the sub-committee of the Electrotechnical Association, (represented by Prof. Kohlrausch and others) that every lightning rod should have its own earth, and that an exclusive conduction of the lightning by systems of piping is not admissible.

Over the installation the use and the treatment of the pipes in the various rooms and storeys of houses, the proprietors of gas and waterworks have in many places no control. They are not even aware of most as long as they remain out of use. The management of such works could not, therefore, undertake the responsibility for the formation of the connections in

such parts of conductors and for their security, especially for the existence of metal rods, over-spanning any gaps or flaws in the piping. There is the further consideration that in some towns there are several gasworks belonging to different companies, and the gas pipes in any given house are not always in connection with the same works. The proposal to use the piping in place of a lightning rod by carrying it out above the roof cannot be accepted.

It seems to the Commission less objectionable to connect the lightning rods with pipes outside the gas or water meter in an accessible place. Even then a satisfactory connection with the mains in the street is essential, and a proper, independent earth for the lightning rod must be insisted on.

According to the above it is evident that the proposed connection is not in all cases absolutely free from danger. If the circumstances are not fully considered cases may arise in which the connection by introducing high electric tensions into dwelling-rooms may give direct cause to danger.

Holtz's theory of lightning rods warns us against indiscriminately connecting masses of metal within a building with the lightning rod, thus introducing the danger of lightning into places indoors, where it would otherwise be non-existent.

In many cases, however, when the mains of gasworks lie in a very dry soil, it does not seem impossible that the conduction of lightning into the earth may be spread over wide distances. Instances are known where the effects of lightning were manifested at a distance of miles. Under such circumstances all branch and house pipes, connected with the mains, may take up very considerable electric tensions, and may, under certain circumstances, become dangerous.

3. *Further Objections.*

The objections put forward by gas and water companies in their own interests relate to the following points.

1. It is not demonstrated whether, in consequence of the frequent transit of lightning through the tube conductors, there will not occur a general loosening of the junctions. Inside houses this might take place in putty joints, with or without hemp threads, in slight solderings, in coupling flanges, and in the screw caps of wrought iron pipes.

In cast metal street mains it may be asked :—

(*a*) Whether the flange connections for joining together wrought iron and cast iron pipes (which are fixed together by felt plates or leather discs, often by means of two or three wrought iron screws of 10 to 13 mm. diameter and coated with hemp) may not suffer, especially as the heads and female screws are rarely in perfect contact with a large surface of the cast metal.

(*b*) Whether the red-lead tissues or the vulcanised plates of the stop-cocks may suffer.

A certain and sufficient conductivity for such strong currents in these connections has not been demonstrated.

(*c*) Whether the tightness of the lead joints will be effected, as the current may occasion changes not merely of form but of structure.

2. Is danger to be apprehended for workmen who are engaged on the mains during a thunderstorm ?

Electricians have already rejected this objection as baseless, and the views of gas and water officials are varied.

The Commission does not consider the objection as baseless.

(The objection is puerile because on the rare occurrence of a storm during working hours the men might cease their operations.)

According to the opinion of a majority of the Commissioners the connection might be permitted on the condition that only lightning rods which have a satisfactory earth should be joined to the gas and water mains. Lastly the objection was raised that the possessors of gas and waterworks, if connections are permitted, might be hindered in the free disposal of their property.

To be safe such companies would, on permitting the connection, have to reserve to themselves the right of freely disposing of their property in the mains, either removing them altogether or altering them at pleasure without regard to any existing connections with lightning rods. They must be in such a position that if in any case disadvantages ensue from the manner in which the connections have been effected, such can be removed at once.

The permission to connect would therefore be revocable and would be granted merely on the admission of certain obligations on the part of the owners of lightning rods.

Especially important is the question whether, and in how far such junctions can be prevented by refusing permission. It must be remembered that in many cases the mains of the gas and the waterworks are in mutual connection, *e.g.*, by gas motors or other machines and appliances connected with both systems. If, therefore, a connection of the lightning rods with either system has been effected with or without permission, the other is affected likewise. On the other hand, in practice, the secret connection of the lightning rods with the piping is, in many cases, not to be prevented, as it has lately been discovered in various towns. Not only have connections of the telephone wires, and the lightning conductors of the telegraph apparatus, been frequently effected with the gas and water pipes in the interior of houses, but this has been recommended as suitable by the Post Office authorities. In many new houses a great number of lightning rods, very imperfectly constructed and injured by rust, have been found joined to gas and water mains, whilst unprovided with any earth connection of their own.

It is a principle with many manufacturers of lightning rods to consider a connection with the street mains as an economical means of dispensing with an earth connection, and thus induce the owner of the house to order a lightning rod.

4. *The formation of the Connections.*

For the proprietors of the systems of piping the question is :

1. The connection with the wrought iron gas pipes within the houses.

It is effected either by means of a broad plate of iron or copper connected to the pipes by means of solder on as large a surface as possible, or by means of a T-piece with a connection stopper.

The application of an iron or a copper piece between the inlet and outlet pipes of gas or water meters is in all cases essential. All connections whose conductivity is open to doubt should be similarly provided.

The connection of lightning rods to pipes of less dimensions than $\frac{1}{2}$-inch (decimetre) internal diameter is not permissible.

Where a plate cannot be soldered on a plate of lead, or of some other soft metal of suitable size is connected with the pipe.

2. Lead pipes are not suitable for connection with lightning rods, as, according to the statements of electricians, the pipes used in practice do not possess the necessary section. According to Prof. Kohlrausch 500 square mm. are required. According to pamphlet No. 1, on the dangers of lightning, a lead conductor must have twenty-fold the section of one of iron.

3. The connection of the lightning rods to the cast iron mains can either be effected by means of a broad plate, or by means of a band with intermediate layers of soft metal. Or a piece of brass or bronze, to which the lightning conductor is soldered, may be screwed in. The clean surface necessary for effecting a metallic connection must be prepared by scraping, rubbing with emery, or filing. The lead plate used as an intermediate layer must have a surface of at least 100 square Centimetres in contact in order to prevent heating.

5. *Recapitulation and Proposal.*

After the above considerations the Commission formulated its views as follows :—

The Commission, according to the statistical data

now available, and to the experience acquired in practice, are not convinced either of the necessity of connecting the house and street piping for gas and water or of the utility of the general adoption of such junctions. It regards the dangers apprehended by electricians on account of the non-connection of the lightning rods as much exaggerated, and sees, even in various respects, positive objections against the general and unconditional admissibility of such connections.

The Commission, however, sees no danger to gas and water pipes calculated to prohibit their connection with well constructed lightning rods, each having its own earth connection.

In order, on the one hand, to meet the urgent demands of the electricians, and on the other, not to disregard the interests of the gas and waterworks, and to put an end as far as practicable to the irregular and dangerous practice of secret connection, the Commission proposes the following resolution :

The German Association of Gas and Water Officials considers the permission of the junction of lightning rods to water and gas pipes admissible under the following suppositions and conditions :

1. The lightning rod to be connected must be provided with its own earth conduction by plates or other suitable fitting. The total resistance of the lead before connection must in no case reach 20 Ω. Whether in any locality a lower resistance must be demanded is left to the discretion of the authorities concerned.

2. The network of pipes laid in the street to which a lightning rod is to be connected either directly or by means of the pipes in the houses must consist of cast-iron mains, the end of each inserted into the following one, and the interstices must be closed with lead or other conductive material.

3. The piping leading from the point of junction to the cast iron main must consist of wrought or cast iron. In the former case the pipes must have at least an internal diameter of 13 mm, and must be placed in perfect metallic connection with the main. No lightning conductors must be connected with lead pipes of the sizes in common use.

4. The execution of the junctions must either be effected by the gas or water company concerned or be done on approved patterns, and under their superintendence.

5. Between the inlet and outlet pipe of every gas or water meter placed in the house concerned, a direct iron or copper junction must be established before the lightning rod is connected. The junction must have at least an equal section to that of the lightning rod. The same precaution must be taken wherever the conductivity of the piping is doubtful, *e.g.*, flanges with felt or leather fittings.

6. As to the practical execution of the junction with the pipes, it can be effected either by a T-piece or by a plate soldered to the mains.

7. Before effecting the connection, in every case the consent of the managers of the gas or water company concerned is necessary. This permission should be given only as liable to revocation at any time, and under the condition that the owner of the house undertakes :—

a. To furnish to the management of the gas or waterworks in question (until an official superintendence of the arrangement and maintenance of lightning rods is established) before effecting the connection, and every two years afterwards, a report drawn up by an approved expert, and certifying the fulfilment of the conditions laid down under the head 1.

b. To allow the company, if requested, to investigate the condition of the connections of the lightning rods with the pipes within the houses.

c. To recoup to the company all costs which may arise from the sanctioned connection of the lightning rods with the piping.

d. At all times to undertake the full responsibility for the good condition of his lightning conductor, as well as its connections to gas or water pipes, and to indemnify the company for all claims of damages arising from the connection granted under its permission or occasioned by the examinations reserved as above.

8. Whether, under any circumstances, further conditions must be demanded, is left to the companies to decide.

(*To be continued.*)

WOODHOUSE AND RAWSON UNITED, LIMITED.

THIS company, as is well known, has taken over the business of Woodhouse and Rawson, Limited, Woodhouse and Rawson Manufacturing Company, and Woodhouse and Rawson Supply Company, together with other businesses at Manchester and Bradford, and has only been in existence six months ; we therefore prefer to make a record of its work during the past year as if it had been in existence during the whole year.

As regards its manufacturing business the extension has been steady and thoroughly satisfactory, Mr. Charles Baker, whose business was taken over by this company, being in charge. The old specialities, which are too well known for enumeration, have been further improved, and the total number produced have been largely in advance of previous years, the turn out of one size of switch alone being over 1,500 per week.

In addition, several specialities have been worked out and acquired ; chief among these we may note the new insulating substance which is just being put upon the market, and which for all purposes to which slate has been hitherto used appears to have a most promising future ; we are promised further details with regard to it very shortly. To this we may add Scott's electric flashing lantern for signalling purposes, which strikes out a totally new line ; experiments upon this have been most successful on board one of Her Majesty's ships during the past four months. Scott's log, a description of which has already appeared in a previous issue, seems to meet a great demand in a very simple manner. Other specialities are their new oil filter and sight feed lubricator, and we hear of very important improvements in incandescent lamps.

The company still continues to be a large manufacturer of automatic boxes of various kinds, both electrical and mechanical.

In the supply department the extension of business has been remarkable, and recently important arrangements have been made for the supply of large quantities of goods of electrical companies abroad. Roughly speaking, the quantity of business done during the slack season has been well in advance of that done in the busy period of the previous year. By the transfer of showrooms and warehouse to 30, Cannon Street, the company has made an enormous improvement ; and although it is not yet completely established in its new premises little remains to be done, and business of all kinds will be greatly facilitated by the extended opportunities afforded to buyers of inspecting all classes of electrical goods.

In common with most electric firms, the contract department of Messrs. Woodhouse and Rawson United, Limited, has been very busy ; it has been principally engaged on electric lighting work, but transmission of power for farm and domestic purposes has been carried out. Police alarm systems, bells, telephones, and plating work have also added their quota to a year's industry. A noticeable and satisfactory feature has been the number of repeat orders from former clients. Among the more important may be mentioned (in house lighting) Lord Brassey, Sir F. Carden, Scrase-Dickens, Esq. In factories, &c., Messrs. J. J. Murphey's brewery, and Messrs. Findlater's.

Among the most important contracts carried out are the palace of the Maharajah of Mysore, and Lord Ripon's house. This department also does a considerable

amount of maintenance work, such as that of Drapers' Hall, Exeter Asylum, and various private places.

At the northern branch of the company's business installations have been carried out at Messrs. Winterbottom's Victoria Mills, Weaste; Falcon Cliff Hotel, Douglas, Isle of Man; Messrs. Crook Frank & Co., Hulme; Messrs. Dobson and Barlow, Bolton, and other important works.

Contracts for the supply of instruments have been arranged with the following:—London and North Western Railway, Caledonian Railway, Manchester, Sheffield and Lincolnshire Railway, National Telephone Company, as well as the Admiralty and other Government departments.

The engineering departments have been very busy, especially in the screw-making section, and a large amount of new plant has been laid down to enable the orders in hand to be executed.

By the acquisition of the Bradford business, where installation work is very brisk (the company being specially appointed as contractors to the Corporation), the sphere of the company's operations in this department has been considerably extended in the North of England.

Among the installations carried out by this branch may be mentioned those at the Menston Asylum, with extensions of the same; Star Music Hall, W. Ackroyd and Company, Sir Titus Salt, Bart., Sims and Company, &c., &c. Electric light has been installed in a large number of buildings in connection with the Corporation's electricity supply, and the only limit to extension of work in this direction is the want of power necessary for the increased number of lamps demanded by the public.

In the early part of the year the company identified itself with the Elmore depositing process, a full description of which has appeared in our columns; careful experiments were made by the company's electrician, which more than fulfilled the expectation held out by the inventor.

An English company has been formed which is just now commencing work, and if we may judge from the market price of the shares, which stand at over three times their face value, the undertaking is likely to be one of remarkable success. If it proves to be all that it claims it cannot fail to be one of the most important commercial undertakings allied with electricity that has yet appeared.

It is rumoured that the application of the same process to another important metal is likely to appear very shortly, but of this we have no definite information.

By allying themselves with inventions of this nature the company has given electricity valuable assistance, and there seems no apparent reason why with its new and powerful directorate, coupled with its excellent working staff, its progress in the future should not be even more pronounced than in the past.

C. A. PARSONS AND COMPANY.

THIS firm has now got its extensive new works into full operation. The premises, which are conveniently situated near the Heaton Station of the North Eastern Railway, in a suburb of Newcastle-on-Tyne, cover two acres of ground, and are connected to the railway by a siding, to facilitate the delivery and departure of heavy goods.

In addition to their other well-known specialities, the firm is now busy with the manufacture of slow-speed dynamos of several types.

Messrs. Parsons & Co. are also carrying out a very extensive order for the Italian Government, for a number of large projectors and automatic lamps of improved design, for coast defence. They have likewise in hand some large contracts for material for the Newcastle and District Electric Lighting Company.

A further quantity of important work is in course of completion, and other contracts are shortly expected.

REVIEWS.

Experimental Science. Elementary, Practical and Experimental Physics. By GEORGE M. HOPKINS. Illustrated by more than 680 engravings. Second edition. New York: Munn and Co.

Those who have noticed the articles by Mr. Hopkins which appeared from time to time in the *Scientific American*, cannot but have wished that the same should one day appear in book form; this wish has now been fulfilled, and we do not hesitate to say that the whole compilation (which includes much new matter), forms one of the most valuable works on experimental physics which has yet been published. We cannot praise it too highly.

The old conventional illustrations which usually appear in works of the kind, and which have no doubt done good service in their time, are, we are pleased to see, conspicuous by their almost complete absence, and in their place we find descriptions of apparatus which may mostly be constructed and used by anyone having ordinary mechanical skill.

The departure is undoubtedly a bold one, but it is amply justified.

With scarcely any exception (it is stated), the experiments described were performed at the time of writing, to ensure fullness of detail and to avoid inaccuracies; the reader of the book can therefore be assured, by following the instructions, that success will be certain.

Practically every department of physics is dealt with, and one is struck with the fertility of invention displayed by the author in designing his illustrative apparatus.

The book cannot (and does not) claim complete originality, in fact the opening chapter on the "The Properties of Bodies," bears a considerable resemblance to the opening chapter of Prof. Pepper's (of "Polytechnic Ghost" celebrity), Playbook of Science (a work, by the way, which is still excellent of its kind), though we do not mean to say that it is in any way a copy of the same.

Chapter III., which deals with the "Gyroscope," is very interesting; it is not often that more than a mere passing allusion is made to this fascinating piece of apparatus in text books. A good example of experimental apparatus is the hydraulic ram, figured on page 80 of the book; the whole arrangement as described could be made by most students without difficulty and exhibits excellently well the principle of the ram. The "Gas Wheel," described on page 87, which shows the weight of carbonic anhydride gas, strikes one as being a most telling piece of lecture apparatus.

The electrical portion of the work is, we think, as good as the other parts, though we could wish that there was more of it; the description of the method of making a model dynamo should delight many.

To go through the whole book in detail and point out its many good features would be an endless task, and we must therefore content ourselves with strongly recommending all lecturers on popular science, and science students, to see it for themselves. The volume can now be obtained in London of H. Alabaster, Gatehouse & Co., 22, Paternoster Row.

Traité Théorique et Pratique D'Electrochimie; 5th and 6th Parts. By DONATO TOMMASI. Paris: E. Bernard et Cie., 53, Quai des Grands-Augustins.

These two volumes, the second of which forms the index to the whole work, completes the issue. The whole book contains over 1,000 pages, and is perhaps the most complete treatise of its kind yet issued. The work of compilation must have been immense, and M. Tommasi is to be congratulated on having so successfully completed his labour. As a work of reference, especially, the book must prove most valuable, the copious index most materially assisting in this respect.

Everybody's Hand-Book of Electricity. With Glossary of Electrical Terms, and Tables for Incandescence Wiring. By EDWARD TREVERT. Lynn, Mass.: Bubier Publishing Company, 112, Broad Street.

This book, though little more than a pamphlet, contains well illustrated chapters on "Electricity and Magnetism; discovery and early experiments;" "The Dynamo;" "Electric Lamps;" "Electric Motors;" "Electric Railways;" "Electric Welding;" "Measuring Instruments;" "Electric Batteries, Bells, &c.," and "Incandescent Wiring Tables." The latter seem a little out of place in the book, as the rest of the matter being of a semi-popular character, those for whom the book appears to be written, would certainly not comprehend the use of the tables; and, on the other hand, those to whom the tables would be valuable, would not much appreciate the rest of the contents.

NOTES.

Lighting of the Tay Bridge.—It is said that the 14 large spans of the Tay Bridge, as well as the piers of the old bridge, are to be lighted with electricity, which will make the traffic on the river much safer than hitherto.

The Incandescent Light in Spain.—The Cadiz Corporation has signed a contract with Senor de la Vresca to light the public thoroughfares of the town with 1,000 incandescent lights of 16 candle-power. Each light is to be used on an average seven hours per day.

A New Lighting System for New York.—The Westinghouse Company is about to supply to New York City a new system of arc lighting, which is said to be free from danger. It will consist of main conductors underground, each lamp being operated therefrom by an induced current just sufficient for itself, and harmless to any person who may come in contact with it. The lamp used will also be entirely new.

Electric Light Accidents in America.—Several accidents have occurred during the past week. On the evening of the 15th two explosions were caused by the electric wires running beneath the roadway in Sixth Avenue. At Hartford a factory operative was killed y grasping an electric light wire.

A fatal accident arising from the system of overhead electric lighting wires was reported on Monday from Newburgh, New York State. A horse while standing touched an iron awning-post with his nose, and fell down as if dead. A man who rushed to assist in raising the animal touched the horse's headstall, and immediately dropped dead; and another man, who attempted to lift the first, received a terrible shock. The cause of the accident seems to have been that an electric wire had become slack, and was lying upon an iron rod extending from the awning-post to a building. The insulating material of the wire had become thoroughly saturated with rain. The horse was not killed by the shock, and the second man was only stunned.

Gravesend Lighting.—The Parliamentary Special Committee of the Gravesend Town Council recommend the council to take the necessary steps, at the first available opportunity, to obtain a provisional order to supply electricity to the district of Gravesend.

Rochester Lighting.—The Rochester Town Council have decided not to oppose the provisional order of the Chatham, Rochester and District Electric Lighting Company, providing that some alterations are made with reference to the terms.

The Lighting of Dundee.—At a recent meeting of the Dundee Electric Lighting Committee, the clerk reported the result of the canvass of gas consumers as far from encouraging to the proposed electric lighting scheme.

The Central London Railway.—At the last meeting of the Holborn Board of Works, the surveyor's report on the proposed electric railway from Bayswater to Arthur Street, West, known as the Central London Railway, was considered, and a memorial from the "inhabitants of Oxford Street," praying the Board to oppose the construction of the railway, was read. After a little discussion, a resolution that no opposition be offered to the measure in Parliament was carried.

The Electric Light at Nelson.—In a few days the works of Messrs. T. Fryor & Co., Chapel Street, Nelson, near Bromley, will be completely illuminated by electricity. The installation, which is being laid down by Messrs. Simpson Bros., Hopton, consists of 50 Edison-Swan lamps of 16 candle-power each, and a dynamo made by a Manchester firm. The dynamo will be driven by the engine which supplies the firm's other machinery. All the wires are insulated with rubber and encased in wood. It is expected that the undertaking will be thoroughly successful, both from a scientific and commercial aspect, and will probably lead up to further enterprise in this direction in the neighbourhood. Messrs. Fryor & Co. are the second firm in Nelson to adopt the electric light as an illuminant, the initiating company being Messrs. W. F. Ecroyd & Co., cotton manufacturers, Lomeshaye Mills.

The Lighting of the Strand.—The Examiner for Private Bills has recently had before him the Strand Electric Lighting Bill, promoted for the purpose of authorising Messrs. A. and S. Gatti to erect and maintain electric lines and works, and to supply electrical energy within the parishes of St. Paul, Covent Garden, and St. Clement Danes; and the St. Martin's-in-the-Fields Electric Lighting Bill, to authorise Messrs. A. and S. Gatti to erect and maintain electric lines and works, and supply electrical energy in the parish of St. Martin-in-the-Fields. Both Bills were found to have complied with the standing orders.

Liverpool Physical Society.—At a meeting held at University College of this Society, on the evening of the 20th, a paper on "Sir William Thomson's Electric Measuring Instruments" was read by Mr. Charles H. Yeaman A. Inst. E.E. The paper was illustrated by diagrams, and various examples of the instruments described were exhibited on the table by the courtesy of Messrs. Holmes and Vaudry, and the firm of Messrs. Cox, Robinson & Co. A short discussion took place, and amongst others, Dr. Howard paid a suitable compliment to the genius of Sir Wm. Thomson in placing such accurate and compact standards in the hands of the electrical engineer.

Sevenoaks Lighting.—At the Sevenoaks Local Board, on Monday last, the 20th of January, a discussion arose as to what representations should be made to the Board of Trade respecting the application of the Electric Trust, Limited, for a provisional order. Mr. W. H. Stepney thought it was an important matter and one in which the board should have a *locus standi*. The Rev. J. Jackson said it was a question whether the board approved of the thing *per se* or not. It was a large matter, but he was satisfied in his own mind that the Electric Trust did not propose to take exceptional powers beyond those taken by gas and water companies. He would propose that they write to the effect that while the board approve of the order as a whole, they reserve to themselves liberty to contest any points of detail. The proposition was seconded by Mr. J. Moore, and carried unanimously.

The Edinburgh Medical Exhibition.—The Paisley Town Council has agreed to subscribe £100 to the guarantee fund of the Exhibition.

Progress in Wales.—The Electric Light Fixing Company are erecting extensive premises at Llanelly, South Wales.

The Royal Society.—A paper by Dr. Hopkinson, F.R.S., on the "Physical Properties of Nickel Steel," was announced for reading yesterday.

Electric Traction going Ahead.—We notice that the Series Electrical Traction Syndicate, Limited, has concluded a contract to work the North Western and Midland District Auxiliary Railway Company's line, 7¼ miles in length, by electricity. It has also contracted for the equipment of a further 15 miles of tramroads at present under construction.

The Telephone in the West.—In the course of a lecture on "The Triumphs of the Telephone," delivered at Torquay last week, before a distinguished audience, Mr. Viccars, F.G.S., gave some interesting statistics as to the progress of telephony in the West. It appears that there are now in connection with the Western Counties and South Wales Telephone Company, throughout the South Western district, 2,204 exchange subscribers and 671 private wires. There are 39 exchanges in the whole of the district, and the exchange at Torquay numbers 167 subscribers. In addition to these there are 33 persons who have private wires. The number of calls in November last, in the district, was 210,000, and when it is remembered that answers had to be given in each case, the number of communications in this one month would number 420,000. There were 4,000,000 calls in 1888, and during the first eleven months of last year there were 4,500,000 calls. The longest speaking connection of the company is from Bath to Llanelly, a distance of 142½ miles. The lecturer expressed his belief that in a short time Torquay would be placed in connection first with Bristol, and then with London and Birmingham, by means of the telephone.

Davey, Paxman and Company, Colchester.—It will be remembered by many of our readers that some 18 months ago we mentioned that a great increase in business had made it necessary for Messrs. Davey, Paxman & Co., to enlarge their works, and that new buildings were erected to take the place of the old pattern shop, which was then cleared, and added as an extension of the foundry. We are glad to be able again to note that this firm is extending its works still further, and is again adding to the foundry, with its already very large boiler shops. The name which Messrs. Davey, Paxman & Co. have won for themselves by the excellence and good performance of their engines, and the honours taken by them at various exhibitions held in the last few years, and particularly at the Newcastle and Society of Arts trials; also the honour conferred upon them by the selection of their engines for doing a large part of the driving at the Paris Exhibition, has, we feel sure, done much to cause such an extension necessary.

Dr. Werner Siemens.—The Berlin correspondent of the *Daily Telegraph* writes: "Herr Werner von Siemens has announced his intention to retire from the firm of Siemens and Halske, in order to devote himself to scientific research. Another member of the firm, Herr von Hefner-Alteneck, has also retired." Given health and strength, Dr. Siemens may be expected to considerably benefit the scientific world, and we hope he will long be spared to carry out his self-imposed task.

The Electro-Harmonic Society.—Particulars of the next Concert may be found on page 10 of Supplement.

Safety of Electricity.—Says *Industries*: "Mr. Ferranti and Mr. Ince are not usually troubled with a *cacoethes scribendi*, so we are agreeably surprised to find an able contribution from their pens in our contemporary, *Engineering*. It is a pity a few articles like these—technically correct as well as popularly written, and also written by acknowledged authorities—do not find their way into the daily press." Since Mr. Kapp resigned his position of electrical editor to this journal we hardly know how to take its comments, but for the sake of the community at large we can only conclude that "able" is a misprint for "miserable." We have so often called attention to the inaccuracies of the daily press science, that when *Industries* speaks of Messrs. Ferranti and Ince's articles as "technically correct," we can only assume that our contemporary's staff is temporarily demoralised by the inroads of "La Grippe."

New Telephone Line.—On Friday morning workmen commenced the erection of a new telephone line between Glasgow and Edinburgh.

The French Government and the Eastern Telegraph Company.—An official decree of the French Government has been published, approving the renewal of two telegraph conventions with the Eastern Telegraph Company, and it is gratifying, writes a correspondent, to learn that the Government have compelled the company to make some concessions in the public interest. The company have to pay a largely increased price for their special line from London to Marseilles, and they are bound to land at Marseilles a third cable, running by way of Malta and Bona, in Africa. The company will also have to reduce their rates for telegrams in plain language to the French Press in the extreme East, and the rates must, furthermore, never exceed those for the English Press telegrams to Cochin China, Annam, and Tonking, viz., three francs a word.

National Telephone Electrical Society.—Mr. Fred. Brown, of the Walsall Electrical Company, read a paper on "Electric Lighting," before this society on Friday evening, the 17th inst. The lecture was well illustrated, and Mr. Brown showed samples of the various materials used in practical work. A vote of thanks was heartily afforded to Mr. Brown at the conclusion.

Improved Rope-Making Machinery.—A newly-designed machine for manufacturing ropes of cotton, hemp, &c., with or without cores, up to 3½ inches diameter, has recently been made by Messrs. Walter T. Glover & Company, engineers and electric cable manufacturers of Salford. One of the special features of this machine, we are informed, is that in the manufacture of the ropes, the yarns and strands all converge to one common centre, thus insuring the utmost regularity in lay and tension. The machine is arranged for making three-strand ropes, each strand being supplied from yarns contained on six bobbins, the yarns for the centre rope being thus supplied from eighteen bobbins. Each of these run with independent motion, and is fitted with separate brakes, which can be adjusted so as to secure an equal tension on every one of the eighteen yarns. This rope machine is very simple and is self-contained, every part being under direct control from the stopping and starting lever; it can be easily controlled by one workman.

New Cable.—The Eastern Telegraph Company announces the opening for traffic of a new cable between Zanzibar and Mombassa, on the East Coast of Africa.

The City and the Rubber Monopoly.—At a meeting of City merchants and others interested in the Para rubber trade, a memorial to Lord Salisbury was adopted requesting that Her Majesty's Minister in Brazil may be directed to procure the withdrawal of the monopoly recently granted to a private trading corporation, giving it the power to compel all other export buyers of rubber to pay a tax of 20 reis per kilogramme on their purchases.

The Brazilian Rubber Industry.—A newspaper in Providence, where extensive rubber works are established, has received advices from Para, stating that the concession recently obtained from the Provincial Government by the Companhia Mercantil de Para permitting it to levy a duty of 20 reis per lb. upon the entire export of Para India-rubber has been cancelled.

The Electro-magnet.—The first of a series of four "Cantor Lectures," dealing with the generalities about uses and forms of electro-magnets, the magnetic properties of iron, induction, permeability, and hysteresis, was delivered by Professor Silvanus Thompson, D.Sc., to a very large audience at the Society of Arts, John Street, Adelphi, last Monday evening.

Breakdown of the Hebridean Cable.—Telegraphic communication with the mainland has lately been discontinued owing to the breaking of the cable in deep water. It is believed that more than one break exists. The cable was laid down some fifteen years ago, and has been twice repaired.

Sale of Condemned Telegraph Stores.—By command of the Postmaster-General tenders are invited for the purchase of 20 tons of gutta-percha, and 2 tons of India-rubber and gutta-percha in lots. The material lies at the Postal Telegraph Factory, Mount Pleasant, E.C. A form of tender, containing all particulars, may be had on application by letter to Chas. E. Stuart, Controller of Stores, Telegraph Street, E.C.

Telephone between Vienna and Berlin.—There is a project on foot for the establishment of a telephonic service between Vienna and Berlin. The negotiations between the German and Austrian Governments have been so satisfactory that there is every prospect that the work will shortly be commenced.

An Association for the Promotion of Electrical Interests.—A meeting, at which representatives of several leading electric lighting companies were present, was recently held under the presidency of Sir John Pender at the offices of the Metropolitan Electric Supply Company, when the desirability of establishing an association of the statutory electric lighting companies within the metropolis, in order to promote the consideration of, and combined action upon, matters of general interest relating to electric lighting, was considered.

Effect of Iron Cargoes on Ships Compasses.—In the course of the Board of Trade enquiry into the loss of the ss. *Dunrobin*, Mr. William Bottomley, who described himself as having for the past thirteen years been engaged in superintending the manufacture, fitting and adjusting of Sir William Thomson's compasses on iron ships, and as having made a special study of the magnetism of iron ships and its effect upon the compass, stated that in his opinion a mass of iron placed before and abaft the compass might, and very probably would, affect it. On the *Dunrobin*, the nearest part of the cargo of pig iron was 10 feet or 12 feet from the compass. The deviation of the ship from her course had been three quarters of a point, and the witness thought it not unreasonable to suppose that such an amount of deviation might have been caused by the pig iron. The court, however, decided that there was not sufficient evidence to establish a plea of this kind. The assessors were quite agreed that at the distance calculated between the highest apex of the cargo and the compass, from 10 to 12 feet, there would have been no such effect upon the compass.

A Good Example.—Coldingham Shore, a fishing village on the Berwickshire coast, has had its public hall fitted up with the electric light. The installation is connected with that of Northfleet House, the residence of Mr. Usher, of Edinburgh, the whole being worked with water power.

Electric Railway for Edinburgh Exhibition.—An electric tramway at an Exhibition is not by any means a novelty; but it does not seem to have occurred to the minds of the executives in the past to make such a means of communication a matter of real utility to visitors. At Edinburgh, however, it is intended to lay out a track, 1,000 yards long. It will form a ready means of getting from point to point of the extensive grounds, and also to the electric launch landing, the several railway stations, and the tramway company's terminus. There will be two stations in addition to the termini. The Electrical Committee now invites tenders from firms willing to equip and work such a line.

The Schanschieff Battery.—This battery is now being made and sold by the inventor, Mr. A. Schanschieff, at No. 5, Appold Street, Finsbury, the Syndicate which formerly held the patents being now in voluntary liquidation. The battery is so well-known to the readers of the ELECTRICAL REVIEW, that we need not refer to it beyond expressing the hope that it may find many channels for its employment.

Electric Tramways for Rome.—According to the Roman correspondent of the *Standard* the Roman Tramways Society has concluded a contract with the English Electrical Traction Syndicate to make experiments upon the line on the Via Flaminia outside the Porta del Populo. The syndicate referred to is the Series Electrical Traction Syndicate of 11, Queen Victoria Street. The line runs to the Ponte Molle, a spot much frequented by the Romans in summer, and on all holidays. The correspondent's statement is incorrect that M. Carl Von Buch is in Rome expressly to superintend the experiments. M. Carl Von Buch has not yet gone to Rome, and Mr. R. O. Ritchie (late of Thompson and Ritchie) is the engineer in charge.

The Electric Lighting of Leeds.—At a recent joint meeting of the Parliamentary Electric Lighting and Sub-Highways Committees, the following resolution was adopted by a large majority:—"That the Council, as the local authority within the meaning of the Electric Lighting Acts, 1882 and 1888, be recommended to refuse its consent to the granting by the Board of Trade of provisional orders authorising the construction of works and the supply of electricity by the National Electric Supply Company, Limited, the Yorkshire House-to-House Electricity Company, Limited, and the Electric Installation and Maintenance Company, Limited, respectively, within the Borough of Leeds; and that the Council be recommended at the end of six months, referred to in the resolution passed on the 2nd October, to instruct the Electric Lighting Committee to report upon the question of electric lighting, with full information upon all improvements which have been made in supplying the light up to that time." The Mayor has called a special meeting of the Council for Tuesday next to consider the question.

International Memorial to Dr. Joule.—It is proposed to raise a fund for the erection of an international memorial to the late Dr. Joule, the discoverer of the law of the conservation of energy. This, we understand, is to have for its chief object the encouragement of research in physical science, though it is also intended to erect a tablet or bust of the deceased in London. In a circular issued by the President, Treasurer, and Secretary of the Royal Society, we are reminded that the importance of the law discovered by Dr. Joule can only be compared to that of the laws of gravitation and chemical combination in extending the beneficent influence of science throughout the world.

Telegraph Poles Wanted.—The Caledonian Railway Company requires 2,000 larch telegraph poles of various lengths. Specifications and other necessary information may be obtained from Mr. J. Lorimer, Charles Street, St. Rollox, Glasgow.

A Step in the Right Direction.—The National Telephone Company announced on Tuesday, to the subscribers to their Liverpool and District System, that the rent for the use of telephones in that centre had been reduced from £20 to £15 per annum; and, further, that arrangements were being rapidly completed for the establishment of telephonic communication between Liverpool and London. Would it not be an equally good policy to let Londoners have the same benefit?

Lamp Renewals.—It has been reported that owing to the difficulty of regulating the pressure in the Bradford Corporation mains, the lamps, being run above their normal voltage, last but a short time. If this be the case, lamp renewals will form an important item in the various installations now being supplied by the local authorities.

Business Change.—The business formerly carried on at Mildmay Park Works, by Messrs. Martin & Co., has been taken over by Mr. D. H. Bonnella, of 58, Mortimer Street, W., who intends, in future, to give special attention to the wants of electricians in the way of turned ivory and wood.

NEW COMPANIES REGISTERED.

Electrical Engineering Corporation, Limited.—Capital, £150,000 in £5 shares. Objects: To take over the businesses of the United Electrical Engineering Company, Limited, and of J. G. Statter & Co., Limited; and to supply electricity for light and energy. To acquire the right to use or manufacture and put up telephones, telegraphs, electric bells, phonographs, and all other electrical apparatus and appliances. Signatories (with 1 share each): *J. G. Statter, Engineering Works, West Drayton; *W. L. Madgen and *E. Manville, 3, Princes Mansions; *C. Samuel, 176, Sutherland Avenue, W.; *W. G. Ainslie, M.P., 21, Ennismore Gardens; *H. B. Statter, Snapethorpe, near Wakefield; P. E. Scrutton, Alliance Engineering Works, West Drayton. The signatories denoted by an asterisk, and Messrs. William Statter and C. E. Charlesworth are appointed directors, the first three being managing directors; qualification, £500 in shares or stock. The ordinary directors will be entitled to £250 per annum, and in addition to one-tenth of the net profits remaining, after payment of 10 per cent. dividend, but the total remuneration is not to exceed £1,500 per annum. Registered 15th inst. by Dowson Ainslie and Martineau, 28, Bedford Row. Registered office, 3, Princes Mansions, Victoria Street, S.W.

Mills Cycle Company, Limited.—Capital £10,000 in £5 shares. Objects: To carry on business as cycle manufacturers, and as electricians, iron and brass-founders, and engineers. Signatories (with 1 share each): A. J. Hills, J. P. Mills, C.E., Mrs. F. Taylor, of Biggleswade, Beds.; A. P. Hills and Miss M. C. S. Marvin, Prince of Wales Road, Battersea; Miss E. Freeman, 20, Victoria Road, Battersea; A. Cosens, 1, Upper Bedford Place, W.C. The signatories are to appoint the first directors, qualification 20 shares; remuneration of ordinary directors, when 5 per cent. dividend is paid, £50 per annum each, with £10 additional for each 1 per cent. further dividend. Registered 18th inst. by Burgess and Cosen, 9, Finsbury Circus.

Bangwaketsi Concession Syndicate, Limited.—Capital £30,000 in £1 shares. Objects: To acquire certain concessions of leases for 999 years, for the selection of trading stations, and for the construction of railways, telegraphs and telephones, and for the production and selling of electric light, and the erection of factories and other industrial works, granted by the paramount chief Bathoen, in the Bangwaketsi country, South Africa. Signatories: George Oliver, 117, Lansdowne Place, Brighton; A. Boyes, 23, Ilbert Street, Queen's Park; E. Partwin, 3A, Shaftesbury Street, Hoxton; H. E. Rowlat, 3, Alma Terrace, Hanwell; W. S. Jewhurst, 83, Mina Road, S.E.; E. Prime, 70, Gracechurch Street; 1 share each. Ferrar Fenton, 20, Bucklersbury, 5,000 shares. The signatories are to appoint the first directors, and are to act *ad interim*, qualification £100 shares; remuneration £100 per annum each, with an additional £10 for the chairman. Messrs. Ferrar Fenton and Reginald Fenton are respectively appointed managing directors in England and South Africa. Registered 20th inst. by R. Jordan, stationer, Chancery Lane, W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Platinum Plating Company, Limited.—An agreement of 18th October, 1889, between this company and the Bright Platinum Plating Company, Limited, provides for the allotment to the latter of 4,400 ordinary fully paid ordinary shares, as part of the consideration for the purchase of the patents referred to in an agreement of the 2nd February, 1889. The original agreement stipulated that the purchase consideration should be £5,000 cash, but it was provided that if on the 2nd February, 1889, the sum of £4,400 should not be paid, the said sum should be reduced accordingly, and the vendors should accept in lieu thereof fully paid up ordinary shares. No part of the said sum of £4,400 having been paid, the shares referred to above are accordingly allotted.

The annual return of the company, made up to the 19th June, was filed on the 1st November. The nominal capital is £75,000 in £1 shares; the shares taken up number 18,582, and upon 6,059 of these 5s. per share has been called, the remaining 12,523 being considered fully paid. The calls paid amount to £1,511 8s. 6d., including £48 12s. 6d. in advance, leaving £51 19s. unpaid. Registered office, 27, Clement's Lane.

Planet Electrical Engineering Company, Limited.—The statutory return of this company, made up to the 2nd October, was filed on the 6th November. The nominal capital is £20,000 in £5 shares. 807 shares have been taken up, and of these 700 are considered as fully paid. Upon the remaining shares the full amount had been called up, but at the date of the return the calls had not been paid. Registered office, 2, Victoria Mansions, 28, Victoria Street, Westminster.

Allchin, Linnell and Company, Limited (engineers, electricians, &c.).—The statutory return of this company, made up to the 2nd inst., was filed on the 4th inst. The nominal capital is £50,000 in £10 shares. 2,000 shares are taken up, and the full amount has been called and paid thereon. Registered office, 9, George Row, Northampton.

Electric Wiring and Fittings Company, Limited.—The registered office of this company is situate at 42, Duke Street, St. James's, S.W.

CITY NOTES, REPORTS, MEETINGS, &c.

The Direct United States Cable Company, Limited.

THE twenty-fifth ordinary general meeting of the company was held at Winchester House on Friday, the 17th, at 2 p.m., to receive the report of the directors for the six months ending 31st December, 1889.

The Secretary having read the notice convening the meeting, and also the minutes of the last general meeting, which were thereupon signed,

The Chairman, Sir John Pender, said the report had been in the hands of the shareholders some little time, and, he presumed, would be taken as read. Nevertheless, he would briefly refer to some of the details, and say a few words with reference to what had been going on in their system during the past six months. The revenue for the half-year ending December 31st, after deducting payments, amounted to £42,356 12s. 1d., against

£34,188, after similar deductions, for the corresponding period of the year 1888. The working and other expenses, including income tax, but exclusive of the cost of repairs to cable, amounted to £15,509 5s. 8d., leaving a balance of £26,847 6s. 5d. as the net profit of the half-year, making, with £2,719 2s. 11d. brought forward from the previous half-year, a total of £29,566 9s. 4d., which had been appropriated as follows: Interim dividends of 3s. 6d. per share to 30th September last, £10,624 5s.; interim dividend of 3s. 6d. per share to the 31st December, £10,624 5s.; total dividends to the two quarters, £21,248 10s.; balance carried forward to the next half-year, £8,317 19s. 4d.; total, £29,566 9s. 4d. The revenue for the six months at 1s. tariff showed an increase of £8,317 19s. 4d. over that of the corresponding period of 1888, when, however, the tariff was at 6d. for two months, and 1s. for four months. The past four months showed a small increase for building expenses; during that period the tariffs were the same. The increase would doubtless have been larger, but for the interruptions for repairs to cables in the period compared. He might mention that the pooled traffic at 1s. showed a reduction upon their pooling of something like 20 per cent. traffic as compared with the traffic at 6d., which showed that while they were working for 6d. there was a very considerable rush of traffic; and now that they had settled down, the difference between 1s. and 6d. amounted, as he had said, to about 20 per cent. The other side of the account showed a total saving of £140 upon the whole of the London items, including a reduction of £160 in printing and stationary. Expenses at stations showed an increase of £385, principally for salaries, in giving slight promotion to several of their operators, who thoroughly well deserved it. The reductions under stations amounted to £200; reductions were shown in law charges, duplex royalty, and insurance of cable; but, on the other hand, the income tax was £82 higher. Including the cost of repairs, the company's expenditure during the last half-year was the lowest on record, as compared with any corresponding half-year since the formation of the company. With regard to the interruptions to the cable, every effort had been made, and with complete success, to secure prompt repairs. The importance of this fact, particularly during a time of competition, could not be over-estimated. He might mention that, in the present case, had the repairing steamers been delayed for another three or four days the repairs, which were completed on the 12th November, would in all probability have been prevented for another five to six weeks, owing to the bad weather which afterwards prevailed, and thereby the cost of repair largely increased, and the pooled revenue seriously affected. He might mention that it was one of the points in the boards' policy, which it had strictly carried out, and had never yet had reason to regret, that when a cable was broken the sooner they could get a ship sent off to repair it the better. They had sent their ships out in all weathers. If that policy had been strictly followed all round the repairs would, he believed, have been less costly, and they would now have £20,000 more in the pool to divide. That was a large sum in a half-year, and he felt quite certain that the example of their small company would be noticed, and probably noticed for good in the conduct of submarine telegraph business generally. The reserve fund account, after crediting it with £4,098 17s. 5d., the interest on the investments, and debiting it with £4,119 14s., the cost of repairs stood at £242,027 5s. 7d. No addition had been made to the fund out of revenue, but this was only an interim half-year, and it must not be overlooked that the company's cable had, in the course of the last two years, been replaced in parts to the extent of about £35,000. He might remind them that at the last half-yearly meeting, when they were just beginning to deal with the shilling traffic, he then referred to the reserve fund, and stated that that fund would have to be looked to at no very distant date. He was not now going to make any proposition with regard to it, but six months hence, at the termination of their financial year, he would make a proposition which, he thought, would strengthen the company and not materially change its dividends. They must find some way of keeping up their income, and at the same time of building up that reserve which had been pooled upon pretty freely. He might mention that during the time of competition, when they were anxious to keep their shareholders as happy and as pleased as possible, seeing that there was a reduction of dividend, they then pooled upon the reserve fund to the extent of £25,000; and, now that they were working upon a higher rate, they must endeavour to put their reserve fund in as good a position, at all events, as it stood in previous years. At the same time the sum drawn from that fund and put into their cable, had gone largely to strengthen their cable; so that by having done, from time to time, a certain amount of good repair to their cable, they would find that at the end of a certain number of years they would have actually replaced their cable out of the reserve fund, and still have made the fund a strong arm of strength to them in the event of another cable being required. Those were the details which the directors thought they were justified in placing before the meeting as fully as possible. He always thought that the more confidence the shareholders had in their directors, the better the machine worked altogether. The companies investments (£239,180 9s. 1d., as they stood in the balance sheet) were now worth above £264,000, or nearly £25,000 more than at cost. Therefore, their securities had not been so badly managed after all. Having stated all he originally intended to state about the working of the company, it might interest them if he took just a very short review of the history of the company and show them that, after all, the present shareholders were not in such an unsatisfactory position. The dividend paid when only six or eight cables were in the Atlantic was 5 per cent. They then accumulated a very considerable amount of reserve. He had told them that that reserve had proved very useful. The dividend now paid was 3½ per cent., but they had ten cables to divide it with. They saw, therefore, that they had now in the Atlantic ten cables against six, and were paying 3½ per cent. as against 5 per cent. It was a very curious fact that when their tariff was 2s. and they had six to eight cables in the Atlantic their earnings had never touched quite a million sterling. They got about £950,000. It had been very much their ambition to touch that million. Now they were working at 1s., and they had altogether, he thought, very close upon £800,000. It had to be divided amongst ten cables instead of six as formerly, and that made a great difference. It was very remarkable how little the Atlantic traffic had progressed during those years. The money got out of it had varied between £500,000 and £550,000, and now, with a sort of medium price, they had a gross income of £800,000. Now, he would like to see the million back again, if possible, and he believed it possible; but he did not see his way at all to change the shilling tariff. There was, however, a prevailing idea nowadays that property ought to be taxed a little more and the burden of the every day man made lighter. He thought they ought to run in the fashionable groove and see whether they could not get a little more upon the cable and leave the shilling man to enjoy a cheap and satisfactory system; and they must exercise their ingenuity in trying to get up their tariff a little at the same time. He felt bound to say, nevertheless, that the position of the company was much improved as compared to what it was when the present board became its executive. Of the 483 then shareholders he believed that, excepting the directors, there were only three who had remained so. When the directors began to agitate the company's shares in the market were about £7; they had risen upon that agitation to £12, and even higher. When the present directors took the cable in hand there was then a very heavy debt of £100,000, which in a very short period they had cleared off. Ninety-seven per cent. of the present shareholders were completely new; within the last ten years they numbered 1,306 as against 483 when the directors took over the company; and, moreover, the shares were £20 shares. The shareholders were getting their 3½ per cent. upon £20; in other words, those who came into the concern later were practically getting their 6½ per cent. to 7½ per cent. for the money. That was not such a very bad investment. It was a very difficult thing nowadays for any man to get 3 or 4 per cent. Taking all things into consideration they were not in such a very unsatisfactory position after all. He would conclude by saying that their cable had never been in better working position than at the present time. When breaks occurred they were liable to lose custom; but there had been a steady increase in their custom during the last three months; and taking their cable, their earnings and their reserve fund, he thought he might say without any hesitation that there was no telegraph company existing at the present time that occupied a sounder and better position. He begged to propose the adoption of the report and the accompanying statements of account.

Mr. Ford seconded the motion, which was carried unanimously.

A Shareholder, in proposing a vote of thanks to the chairman and directors, expressed himself as considerably disappointed at the traffic returns not having been considerably larger, considering the number of Americans in Paris. Still, the position of the company was so greatly superior to what it had been in times past that he felt the shareholders would be only doing their duty in expressing their most cordial appreciation of the directors' services. The result of the past half-year was satisfactory, if not promising. He thought the time had fairly come when the board, being a strong one, should publish its traffic returns.

Mr. Varley seconded the motion. Especially he thanked the chairman for his promise to strengthen the reserve fund.

The Chairman, in reply to the mover, said people when out on pleasure found many ways of spending money without spending it on telegrams. Americans away from home never lost sight of the main point; they were all men of business, and the ladies were good men of business, too. (Laughter.) They generally arranged a little code in which one word gave all the information that was necessary. He had been astonished at the amount of ingenuity shown by them in making codes and getting an amount of matter into very small compass; and he was sorry to say they were growing so fast in that direction that it prevented the submarine telegraph companies from growing in the direction of larger dividends. Telegraphing had become a positive necessity. No man could live in trade unless he made use of submarine telegraphs, but at the same time there were so many modes of expressing in a couple of words, matter which written at length, would occupy a sheet of foolscap, that, although he had been a merchant himself all his lifetime, and had seen some merchants codes, he had sometimes been perfectly astonished. And he might say that it could not be put a stop to, and he would do precisely the same thing in their place. All they had to trust to now that the submarine telegraph was becoming such a necessity for mercantile use was the progress of trade between the two countries. There was no surer barometer than the submarine system for showing that, and he was happy to say that at the present moment trade throughout the world had probably not been in a more satisfactory state for a great many years past. Regarding the reserve fund, it was the root and strength of any company. It had been the board's desire all through to make sure of a steady dividend rather than a very high one. They had thought it better to have an extra reserve fund than to pay an extra per cent. when they

might have done so, and they have benefited by this policy in spite of hard and bad times. They hoped to be able to bring the company back to something like the position it occupied before the bad times. In regarding the publication of traffic returns, they were so situated with reference to other companies that they could not do this independently. Their relations with the Commercial Company were very satisfactory, they were not competing with one another, except as to who should do the work the best; but they did not get that company's returns, nor did they give them theirs; and any statement that might be made in another way would be misleading. Above all things, he deprecated the publishing of sensational returns. He thanked them for the vote of confidence, and the meeting then broke up.

The Eastern Telegraph Company, Limited.

THE 35th half-yearly ordinary general meeting of this company was held on Thursday week, at Winchester House, Old Broad Street, E.C., under the presidency of Sir John Pender, K.C.M.G.

The Secretary having read the notice calling the meeting, the following report of the directors was taken as read:—

"These accounts and balance sheet are for the six months ended September 30th, 1889.

"The revenue for the period amounted to £351,014 19s. 4d., from which are deducted £87,730 15s. 9d. for the ordinary expenses and £49,634 11s. 6d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £4,724 10s. 11d. for income-tax, there remains a balance of £208,925 1s. 2d., to which is added £974 15s. 6d. brought from the preceding half-year, making a total available balance of £209,899 16s. 8d.

"From this balance there have been paid—

Interest on debentures and debenture stock	£28,274	12	7
Dividend on preference shares	20,474	2	8
Two interim dividends of 2s. 6d. per share each on ordinary shares	100,000	0	0
	£148,748	15	3

Leaving a balance of £61,151 1s. 5d., which is carried forward to the next account.

"The revenue includes £37,318 4s. 11d. dividend for the half-year upon the company's shares in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies. The cables of these companies are in good working order.

"All the sections of the company's cables, without exception, are in good working order.

"During the past six months, in consequence of the political disturbances in the Island of Crete, the telegraph lines on the island were interrupted.

"The directors applied to the Turkish Government for permission to lay a duplicate cable between Canea and Candia, a distance of 70 knots, which was required for the increased amount of traffic thrown upon the company's cable by the interruption to the land lines. As it was of the greatest importance to the Turkish Government that telegraphic communication should be efficiently maintained between the Porte and Crete, the Firman was at once granted and the cable laid, the cost of which has been charged to the reserve fund.

"To meet the requirements of the increased traffic new cables have been laid connecting Patras with Corinth (75 knots) and Piræus with Kalamaki in the Gulf of Athens (31 knots). The cost of these cables has also been charged to the reserve fund, as well as that of the Perim-Oboch cable referred to in the last report. The laying of this cable was completed on July 17th.

"In accordance with the articles of association, two of the directors, George Garden Nicol, Esq., and John Denison Pender, Esq., retire by rotation at this meeting, and, being eligible, offer themselves for re-election.

"The auditors, Mr. Henry Dever and Messrs. Welton, Jones and Co. retire, and offer themselves for re-election."

The Chairman, in moving the adoption of the report, said: The revenue for the past year had been exceptionally good, and the directors hoped that that would continue. The general revenue of the company depended a great deal upon the trade of the country; indeed, the telegraph system was about the best barometer of trade existing; and the company was participating in the improved trade of the country. The greater part of the increase was caused by the development of business in South Africa, and the increase had taken place in all classes of their traffic. Their total working expenses for the half year amounted to £87,730, as against £83,332, an increase of £4,398. The large amount carried forward would be dealt with next half year, and would be equal to a considerable bonus. Last year the company had completed the whole circuit of Africa, and that was the largest thing done in submarine telegraphy, involving 17,000 miles of cable. The only country that had not assisted the company in any way was Germany, which was now trying to get a hold in Africa, and which found that to get a hold there it must do something for submarine telegraphy. He hoped that at the next meeting he would be able to state that Germany was taking part in submarine telegraphy. Such was the strength of this company's position that he did not see how other nations could interfere or do any serious harm to it.

Lord Tweeddale seconded the adoption of the report, which was agreed to.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors on Friday last, it was resolved to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on the 31st January next, the declaration of the following dividends:—(1) A balance dividend of 15s. per cent. upon the ordinary consolidated stock for the year ending 31st December, 1889. (2) A balance dividend of £1 10s. per cent. upon the preferred stock for the year ending 31st December, 1889, both payable on the 1st February next, less income tax, to the stockholders registered on the books of the company on the 13th instant. After paying the foregoing dividends there will be an estimated balance of £2,247 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £2 15s. per cent. on the ordinary consolidated stock, and £5 10s. per cent. on the preferred stock for the year 1889. The register of transfers will be closed from 17th January to the 31st January, both days inclusive.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending January 17th, 1890, amounted to £4,750.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending January 17th, 1890, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £3,432.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th January are £2,930, as compared with £2,454 in the corresponding period of 1889.

LEGAL.

The Northern Electric Wire and Manufacturing Company v. Hall.—On Friday last, in the Chancery Division of the High Court of Justice, Mr. Justice Kay was moved in the matter of the Northern Electric Wire and Manufacturing Company by Mr. Renshaw, Q.C., on behalf of Mr. E. W. Hall, of Park House, Bradford, to rectify the register of the company by omiting the applicant's name from the list of shareholders in respect of 160 shares the company purported to allot to him, and for the repayment of the sum of £80 paid on application, together with interest thereon and the cost of the present application. Mr. Renshaw stated that the company was registered on the 25th June, 1889, with a capital of £20,000. About a month prior to the registration of the company Mr. Hall received a prospectus from one of the promoters, and on the 3rd July sent in an application for 160 shares, paying 10s. per share in respect of them. On the 14th July he received a so-called letter of allotment, which was unstamped, and the real question in the action was whether that allotment was good and effectual. On the 29th July the directors of the company who had been appointed passed a resolution to the effect that a certificate should be issued to Mr. Hall in respect of his shares. This fact, however, was never communicated to Mr. Hall, and he knew nothing about it until after the present motion was taken out. On the 14th August, 1889, Mr. Hall withdrew his application for shares, and on the 23rd the company sent to Mr. Hall a letter, enclosing a new letter of allotment, but dated 14th July, although the stamp showed it was made out on the 22nd August. On the 10th September, 1889, Mr. Hall's solicitor demanded repayment of the £80, and it now turned out that the company had taken on themselves to forfeit the shares. Mr. Marten, Q.C., for the company, suggested that as there were several questions of importance raised that would take some time, it would be best that the motion should be directed to go into the general list. Mr. Renshaw agreed to this course on condition that things should remain in *statu quo*, and that no proceedings should be taken to recover calls from Mr. Hall. Mr. Marten consenting, Mr. Justice Kay directed the motion, together with all questions relating to the matter, to go into the general list.

Re James Fyfe.—On Wednesday, at the London Bankruptcy Court, the first meeting of creditors was held under the failure of James Fyfe, describing himself as an electrician. Up to the year 1884 he was managing director to the Pilsen, Joel, and General Electric Light Company, Limited, and in 1887 acted as part promoter of the Ross Oil Lighting Company, Limited, now in liquidation. He was one of the original promoters of a building scheme called the "Brixton Improvement," and was also promoter in England of a scheme for lighting by electricity the town of Las Palmas, Canary Islands, the concession for which has not yet been granted. The debtor stated that he had been unable to file his statement of affairs, not being able to get certain necessary particulars, and, further, that he had hopes of paying the petitioning creditor and having the adjudication annulled. He did not think he could make any offer, although perhaps he might obtain something from his friends. In all probability about £14,000 of his liabilities would not rank against the estate. If left free to act, he would ultimately be able to pay his creditors in full. Eventually the matter was left in the hands of the Official Receiver, it being understood that if the debtor had an offer to make to his creditors a meeting would be called to consider it.

TRANSFORMERS.

DISCUSSION on Prof. Harris J. Ryan's paper on "Transformers" published in the REVIEW of last week.

Mr. TOWNSEND WOLCOTT: Did I understand Prof. Ryan to say that the loss of energy is necessarily less where there is mechanical vibration?

Prof. RYAN: It seemed to us to have been so in this transformer; but we are not sure of it.

Mr. WOLCOTT: On the supposition that it is so, where does the energy come from? The idea is that the reversal of polarity of the iron absorbs a certain amount of energy in any case; is it not?

Prof. RYAN: The idea, I suggest, amounts to this: that the energy that was taken up in shocking that iron was less than what was saved in the hysteresis. That is, the hysteresis was made less by a greater amount than the energy that was spent in shocking the iron.

Mr. WOLCOTT: That is the way I understood it; but is there any explanation why that should be so?

Prof. RYAN: Not that I know of. I have not thought of the matter to any great extent, or further than I have indicated.

Mr. NIKOLA TESLA: Prof. Ryan has said that the form of the primary current wave departed considerably, in certain conditions, from that of the primary electromotive force; and he also stated to what he thought this departure due. I think that this departure of the primary current wave from that of the impressed electromotive force is due, to a considerable extent, to the conditions of the secondary circuit of the transformer, and I regret that Prof. Ryan has not shown in the secondary an inductive resistance instead of the lamps. I think that then there would have been found a still greater departure of the primary current from the primary electromotive force. If we close the secondary circuit through a non-inductive resistance, such as lamps, it diminishes the lag of the primary. If we close it through an inductive resistance it increases the lag of the primary. In this way two effects may be produced; first, the primary current wave will depart more or less from that of the electromotive force; second, the secondary electromotive force will lag behind the primary electromotive force, as Prof. Ryan has found.

Prof. RYAN: I would like to ask Mr. Tesla how he would produce that inductive resistance in the secondary circuit?

Mr. TESLA: When you close the secondary circuit through the resistance, suppose that you put a coil of wire in the circuit instead of the incandescent lamp.

Prof. RYAN: Would you not be increasing the hysteresis effect in that way? It seems to me that then just what you say ought to follow? Of course it should be understood that stress is laid merely on the fact that there is a certain component at all times flowing to keep up the magnetism; but, aside from that, whatever current passes is merely the opposite of that which passes the secondary circuit.

Mr. TESLA: You stated that this departure was due only to the hysteresis.

Prof. RYAN: Suppose that you use hysteresis in the secondary circuit, and thereby augment the irregularities of the primary circuit; is it not, after all, ultimately due to the hysteresis?

Mr. TESLA: But suppose instead of the incandescent lamp you use a coil of inductive resistance, which would take the same current as the lamp?

Prof. RYAN: When you use any device by means of which you introduce hysteresis in a secondary circuit, do you not greatly augment the displacement of the primary current?

Mr. TESLA: Of course as we load the secondary with lamps the primary comes closer and closer to where it ought to be; and I think if you had made a trial with an inductive coil in the secondary circuit instead of the lamps it would have shown some interesting conditions. I believe Prof. Ryan stated that the secondary electromotive force commenced at a given point to lag behind the primary electromotive force?

Prof. RYAN: Of course it is gradual.

Mr. TESLA: Have you not noticed, for instance, when this takes place, that it began suddenly?

Prof. RYAN: No; I have not noticed that it began suddenly.

Mr. TESLA: I should say that when the secondary circuit has a different retardation from that of the primary circuit, then this condition begins. That is to say, if you have a primary coil, and you pass the current through that coil, and you have the secondary circuit closed, you then observe a certain lag of primary current. Now, if you add in the secondary circuit an inductive resistance, you can cause a still greater retardation in the primary. And if you diminish the retardation of the secondary, by inserting lamps, you diminish the retardation of the primary circuit to a greater extent than that of the secondary; thus in both cases causing the secondary electromotive force to lag behind the primary.

Prof. RYAN: I would like to say that Mr. Merritt and I intend to continue our work in this line, but, of course, we wish to vary the circuits upon which we experiment. As soon as we have done this work on the transformers we expect to take up the action of the condenser in all its relations to circuits possessing inductors, and to circuits not possessing inductors; and will test this matter which Mr. Tesla has just spoken of by working a coil in the secondary circuit, instead of a lamp. I think that a great deal is brought out in this way; and that one would be able, by careful study, to predict fairly well what would take place by varying the conditions.

Mr. A. E. KENNELLY: There are two points about which I would like to ask Prof. Ryan. One is with reference to that very distorted curve that we see upon the first sheet, representing the values of the electromotive force and currents when the secondary is open. I understood Prof. Ryan to say that the square root of the mean square of the primary current corresponding to that distorted curve did check with the average of the square roots of the ordinates as compiled in the series. Now that statement, supposing it to be rigidly accurate, is tantamount to an assertion that the primary curve, which looks so distorted, has really the position of two sine curves; because, if I mistake not, the sine curve is the only curve which possesses the property that the square root of the mean square should represent that average. It would therefore mean this: that the primary current, starting under the impulse of that primary impressed electromotive force (which we will assume to be a true sine curve) shall meet with an opposing force, which is of itself a sine curve. I think it is important to know whether that is so or not. I think it would also be interesting to know how far the observations before us show whether the curve of the impressed electromotive force is of a true sine nature or not. We know that it approximates to it in a great number of cases; and we know also that in alternating current dynamos the curve is by no means of a true sine type. It is fundamental in the whole subject we are studying to know how far the deviation is from the theoretical sine curve. The question of hysteresis is of very great importance in every point of view. We know that we can measure the amount of energy which a converter absorbs in a given time; and we can measure also the amount of energy that it delivers in a given time. We have then to deal with the remainder of energy absorbed by the converter uselessly; and this is to be found, first, in a purely frictional resistance to the current, whereby the energy is transformed into heat; and second, in the effect of the magnetism there is in the current producing the magnetic lag. It is of the very highest importance that we should be able to separate those two forces; and the paper before us gives very important suggestions by means of which we can carry that differentiation into effect. The Foucault currents can be reduced sufficiently by diminishing the cross-section at any one point; and we know that in good transformers such currents can be reduced to a minimum; but what we do not know is the quantity of energy which is being absorbed in the hysteresis under the conflicting conditions which are perpetually occurring. In civil engineering we are brought face to face with the wonderful fact that a very large portion of its application and design lies in the general knowledge of the properties of the molecules of iron in the different conditions in which iron is used; and the mystery grows more and more when we remember that in electrical engineering it is not so much the mechanical properties of iron, in the mechanical engineering sense, as it is the electrical properties of iron, which concern us, and which vary perpetually in every design for apparatus; because, after a piece of apparatus has passed from the stage where the wonder is no longer new, then the question comes: How much can we economise and save out of a given mass of iron or copper? And the question, which is coincident with that, of how much we can save, or waste of hysteresis in iron becomes of greater and greater importance. In hysteresis we have two distinct things to deal with; first, we have the fact that the iron will not return immediately to its previous condition after some magnetic effect has been impressed upon it; and, secondly, that it has a frictional resistance, and cannot instantly obey the reversed force. In all slow working transformers, in all pieces of apparatus where the changes are slow and steady, we can generally neglect what is called the frictional hysteresis due to speed, and simply deal with the static hysteresis; and it becomes of the very greatest importance that we should be able to distinguish between the statical hysteresis and the physical hysteresis. With regard to the question asked as to the effect of mechanical shocks on hysteresis, I think I may suggest a possibility, namely, that it is simply a question of how the magnetism which has been left after a given impulse can be shaken out; and if you can shake that magnetism out by any means you will have that hysteresis destroyed. If you will study the hysteresis chart before us you will see that the area of the curve represents actually the amount of energy which is being consumed or delivered from the cycle in the iron through its magnetic effect; and if you can prevent that taking place that lag would disappear. I think the question of the differentiation of the physical hysteresis from the static hysteresis is one which has gone beyond experimental methods, and has become one of very great importance; and if words were necessary to recommend its importance still further, is it not enough to consider that apart from practical considerations it has also a very important scientific bearing; because, by the way in which magnetism acts upon iron (the most completely magnetic substance we find in nature) the more readily can we guess at the principles which underlie the whole phenomenon of magnetism; and the more completely can we discriminate the different conditions under which that iron acts, the more truthfully shall we be able to guess at the conditions which nature imposes upon that iron.

Dr. WM. E. GEYER: I would like to ask Prof. Ryan (if he will be kind enough to turn to the chart showing the primary electromotive force) if any peculiarity was ever noticed about half way up in the curve of the primary electromotive force; a sudden departure from the smooth curve.

Prof. RYAN: Yes; as I think of it now.

Dr. GEYER: Last May and June there was made, under my general supervision, a very similar experiment, where, however, we used a condenser, and discharged the condenser through a

galvanometer, and in that way measured the relative dimensions of the electromotive force. We also got curves which were very smooth indeed (we took points more numerous than those that are drawn on the chart before us), until we got to a point about half way up, where we obtained results which at first we thought irregular and accidental. We skipped that part of the curve and went further up, when again it was extremely regular, until we got down on the other side to about the same height, where again the irregularity began. The irregularity was so precise that it meant to my mind that it was not a simple accident of the experiment. We then took especial pains to determine points extremely near together just in that region, and persistently obtained a very decided jog in the curve; that is, a sudden upward motion, and a sudden downward motion, at the end of which the perfect regularity of the curve was resumed; and on the other side again there was the same irregularity, and the same jog on the lower curve again. I have not found any satisfactory explanation as to the cause of it. If any could be offered by anyone present it would be very interesting. I might mention in addition that when these same curves were determined on an open circuit, or on a non-inductive resistance, the irregularities were not noticed. They were only noticed when the transformer was a part of the main circuit.

Mr. TESLA: May I ask whether the machine was run at a constant number of alternations all the time?

Dr. GEYER: The machine was run at constant alternations—the regular commercial speed.

Mr. TESLA: I think if the number of alternations had been varied, greater irregularities would have been observed. I think it will be found that if a higher number of alternations had been chosen, the irregularity would have been more pronounced, until a certain limit was reached. I have run them as high as 150,000 alternations per minute. Where the alternations were very low the irregularity disappeared; but when the same number of alternations, with a longer magnetic circuit in the transformer was employed, they would again appear. So that, as I know that the magnetic lag was varied by the length of the magnetic circuit, I assume that this was the cause of the irregularity. Mr. Kennelly has very ably, and rightly, brought up the importance of the study of hysteresis. I think this is a field in which we should all work and achieve considerable improvement; so much so that certain of my experiments have been rather surprising; and in investigating the cause of the lag of the iron we will find the experiments not only of value to investigators but of real value to us practically.

Mr. JOSEPH WETZLER: In reference to the remarks made by Dr. Geyer as to the cause of the notch in the curve, it seems to me that it might principally be due to irregularities in the nature of the field. The field poles may have different intensities over different parts of the surface, so that if more strongly magnetic all around the edge than at the centre they would produce an irregular field, which would cause a corresponding effect in the current produced, so that all of the curve would not be regular.

Mr. C. O. MAILLOUX: I am inclined to believe that the theory advanced by Mr. Wetzler is the correct one; and I think that the notch in the curve is accounted for by the dynamo, rather than by the reaction of the converter upon the impulse. The fact is, that in a dynamo we never have a uniform distribution of the lines of force, from the very fact that towards the centre the lines of force are more dense than in the area which is contiguous to the edges. The consequence is that when a coil is approaching the edge of the pole it is approaching a spot where the lines of force are more dense; and after it has passed that spot it finds itself in a place where the lines of force are not so dense. It again meets towards the middle of the pole, a place or period where the lines are denser; and again as it comes to the outer edge, a place where the lines of force are not so dense. Now, if you bear in mind the fact that the lines of force are merely the exponents or indicators of the condition of the magnetic medium, showing that there is a highly elastic substance under great stress or tension there, then we may replace those lines of force by elastic substances; and you will find on theoretical reasoning that you would naturally expect that the action of the wire, the moment that it begins to have the current in it, would be reacted upon the lines of force and displace them at that point. We know that such is the case in continuous current dynamos, but not with alternating currents. We know that the lines of force are distorted and thrown out of their course by the action of the current in the armature itself. Prof. Elihu Thomson has shown by experiments that there is such a crowding effect on the lines of force that, as a matter of fact, the area of the coil, or the contour of the coil, encloses a smaller area of them than the area of the pole possesses. I should imagine that the notch in the wave of the impressed electromotive force would be due to the fact that, as the current approaches, it first meets with an obstruction which is too stiff for it to bound over, and therefore immediately quits the line of force, creating a high tension, which produces a higher electromotive force. Then we come to a place where the field is more uniform, and consequently we get the action which we would naturally expect—a current more nearly uniform, and at a rate more in accordance with some fixed law. Then as we come to the outer edge we must pass through another crust of the lines of force, and we would naturally expect to find another big break and a slight up-wave. Pursuing the same reasoning you will find that this would take place just exactly as Mr. Geyer has found by experiment; and that the speed at which the alternations occur have a great deal of influence upon that. I should have expected that the loss of force, being like all electric substances, more brittle to a rapidly acting force, would show that effect more perceptibly at higher alternations than at lower ones.

Mr. TESLA: Just a word before you pass to another subject. That opposition which was alluded to as occasioned by the dynamo machine might not have its cause in the machine; but that very kind of opposition may exist in the transformer itself; and there is where I believe it does exist. I was some time ago engaged in some work in getting direct currents from an alternating current; and I found that I was able to produce a preponderance of current impulses in one direction over those of another; and then I found that under certain conditions an opposition appeared, exactly as was stated by Mr. Mailloux in regard to the dynamo machine; and that such conditions can be brought about; and that they depend greatly upon the iron, on the number of alternations, and the length of the magnetic circuit. Imagine, for instance, that you have in the magnetic circuit of the transformer magnetism in one direction set up; certainly if such magnetism exist it will oppose the passage of a current of a certain direction; and in this way a certain modification of the curve would be brought about.

Mr. MAILLOUX: I am very glad that Mr. Tesla spoke of that. I might have gone farther, and said that undoubtedly the same phenomenon would occur in the transformer core itself, and that there would be changes of magnetism there under different circumstances; that inasmuch as he has so much more ably explained it than I could, I need not refer to it again. The only other point I wish to advert to is in connection with some of these curves. I would like to ask Prof. Ryan whether he has taken the trouble to follow the concomitant variations of the values of the inductance; that is to say, the instantaneous values that we are supposed to get for the inductance at different variations of the electromotive force, so that we might be able to get a means of comparison between theory and practice. As we all know, the theory of the transformer is one thing, while the practice is another thing, quite remote and apart from it; so much so that the theory, although it is not yet complete, is already behind the times. We know also that that innocent looking symbol designated by L, which represents the inductance in a transformer circuit, does not happen to do so in the transformers which we use in practice. It does so on paper, and in mathematical equations, and also in transformers which have no iron. Now it would have been quite interesting if Prof. Ryan had undertaken either to calculate or derive the value given for the inductance, so that we might from that calculate the impedance of the circuit; or, in other words, that spurious resistance factor by which we must multiply the square root of the current in order to get the energy that appears in the circuit.

Prof. RYAN: If I have understood Mr. Mailloux's question I will answer it in this way: That if you take what is the accepted theory of the transformer up to date, and which assumes always, I believe, that the relation of the current and magnetism of the iron is the same in an up curve, as it is going down; taking that theory as it has been elaborated, and the suggestion made by Lord Rayleigh about a year ago, that is to say, taking the transformer and observing the relation of the magnetism of the iron corresponding to any particular number of ampère turns going up and coming down, to modify that theory (because it is not always the same), and when you have measured the difference that exists in going up and coming down, you will get exactly the state of affairs that are here found actually to exist. The suggestion that was made by Dr. John Hopkinson in a note published in the Proceedings of the Royal Society a few years ago, made a faint suggestion that if you assume *this* curve, and substitute for that curve a curve as modified by the values which you obtain in hysteresis, you will get precisely this state of affairs. One thing more with regard to the method by means of which you can express the exact shape of those curves mathematically, and therefore proceed by means of mathematical investigation, and by means of the impressed electromotive force that we have here given, to find what it is, and what should follow: I will say that Mr. Merritt has carefully analysed the properties of those curves, and has shown that the impressed electromotive force curve is made up, in the first place of a sine curve in unison with it, and another curve of the third order running along like *this*, and finally one of the fifth order; and if we should carry it one further we should find with it one of the seventh order—in odd orders, the even orders having disappeared, or else the magnetism would be heavier on one side than on the other. But matters of that sort are very technical; and I did not think that these curves, representing the constituents of these various curves, would be of much interest, or I should have brought them with me.

Mr. E. G. ACHESON: I understood Dr. Geyer, in speaking of the notch in the curve, to say that he obtained it only when he had the transformer in. That being the case, it could scarcely be due to the machine.

Dr. GEYER: The notches were not obtained when the dynamo was run on an open circuit.

Mr. KENNELLY: In that case, I venture to say that it must be due either to the magnetic lag, or else to a variation in the self-induction. If the processes of self-induction were variable it might be expected. With such variations it is probable that such kinks would follow.

Dr. GEYER: Am I right in understanding Prof. Ryan to say that the efficiency of the transformer was 85 per cent.

Prof. RYAN: Eighty-six and six-tenths per cent. when working with ten lights in the secondary.

Dr. GEYER: Was that efficiency tested also in some other way?

Prof. RYAN: No; it merely came in as a secondary matter.

Mr. MAILLOUX: It strikes me that Dr. Geyer knows more than he wants to tell us about the transformer tests. I have been told that some extensive work has been going at Stevens Institute, and it would be interesting to get some information about it.

Dr. GEYER: What I could say about it has already been published in the journal of the Franklin Institute. It would have been read before this institute, except that it came late last year, in June, before the summer vacation; and there were so many other papers that it was crowded out. The other tests we made are very much like those of Prof. Ryan, except that we used a condenser as a means of measuring the electromotive force; and we worked a 20-light transformer instead of a 10-light; and the mechanism for taking off the instantaneous electromotive force was slightly different. It is hardly worth while to go through details, as a larger part would be repetition, I have not seen anything in Prof. Ryan's charts that differs from those that we obtained. So far as I can see, the results are essentially of the same nature.

The CHAIRMAN (vice-president T. C. Martin): I understand that Mr. Stillwell, who is Mr. Shallenberger's associate, is here, and if he is moved to speak we would be glad to hear from him before the meeting is closed.

Mr. L. B. STILLWELL: The work that Prof. Ryan has introduced to-night is in the general line that we have been working on for two or three years. I had not intended to add anything to the discussion, but there is one point that I might mention which may possibly be of interest, and that is, that we have noticed the point to which Prof. Ryan referred in the case of a 10-light transformer, wherein he found that the loss due to the iron decreased as the load is added to the transformer. We have observed that this decrease is more marked in the case of a small one. In a 40-light transformer the iron loss is more nearly a constant; and it seems to me that this fact is in the line of the explanation which has been suggested, as to the shaking out of the magnetism, and the consequent decrease of loss in iron at heavy load in small-sized transformers, as larger ones would be somewhat less liable to mechanical vibration. If I have understood the diagrams correctly, there is one other point which differs slightly from the observations I have made, in which observations, however, I used the divided electro-dynamometer method of measuring the angle of lag. Of course, that method is based upon the assumption that these are sine curves. Applying that method we have found that the lag factor or co-sine is somewhere in the neighbourhood of 70 degrees; and as load is added to the secondary the factor increases more rapidly than shown by the curves that Prof. Ryan has drawn. For example, with five lights on the secondary I have found that the primary and secondary currents are practically 180 degrees apart, the co-sine of the angle of lag being about 98 degrees. With that explanation the discrepancy may possibly be due to the irregularity of the primary current, as the diagram by Prof. Ryan shows. I will say that we have also quite recently adopted a method of drawing an accurate diagram of the wave E.M.F. The method is due to Messrs. Scott and Morris, of our laboratory. I have not applied it yet, and have not seen it applied to the purpose of noting accurately the form of wave derived from our ordinary machines, since we have been more especially engaged on new types and various experimental work. The method, however, would afford a very ready means of checking up this observed kink in the curve; and I shall take the trouble to make experiments as soon as possible, to throw light on that point. The method in question consists simply in mounting upon the armature shaft a wooden disc with a metallic contact at one point in the periphery, this point being connected with one terminal of a voltmeter, while the other terminal of the voltmeter is attached to one collector of the dynamo. A brush that is connected with the other collector touches the metallic point on the disc once in each revolution. By altering the position of the disc we can get a potential reading on the voltmeter proportional to the electromotive force developed by the machine at any given position of the armature, and moving it gradually through 180°, we have obtained surprisingly accurate results—the quantity of current through the voltmeter being large and the time being very slow. The cards I have seen made out in the last week are very accurate, and show perhaps 40 points on a phase diagram. I regret that I have none of the cards here, as they might be interesting in connection with the points brought out. I would like to add one observation, and it is with regard to the observed efficiency of the transformers. It is, of course, understood that the efficiency of a small transformer is necessarily much less than that of a large one. The conditions heretofore have been such as to compel the use of small transformers, but the tendency, as we observe it, is very largely towards the use of larger ones. This tendency will do away in a great measure with the implied criticism upon the efficiency of the transformer system.

Dr. GEYER: I might say that three years ago, when the then existing methods of measuring the efficiency of such apparatus were very uncertain, we resorted to some heroic treatment of it. We stripped the transformer of its outer coil (which I think has not much to do with its efficiency) and the whole transformer was immersed in kerosene oil, and the transformed current was also used up in a calorimeter, consisting of a jar of kerosene; and then we found that as the load was increased the proportion of heat in the calorimeter to the total heat produced, was less and less as the load was made greater and greater.

Mr. TESLA: Mr. Stillwell has alluded to a method of tracing the wave. I would like to ask the members if any of them have ever made an attempt to find out whether there is a difference when the laminated sheets of the transformer are loose or tight, and if not, I wish some one in his idle hours would investigate that; because I have reason to believe that there is a difference when the sheets are tight and when they are loose. Of course, it might be due to the imperfect contact of loose sheets, which would tend to diminish or increase the circulation of Foucault currents.

THE BROOKLYN SUBWAYS.*

FINAL REPORT OF THE COMMISSION—INTERESTING REVIEW OF THE UNDERGROUND AND OTHER WIRE WORK IN BROOKLYN.

THE official end of the Subway Commission of Brooklyn occurred October 31st, 1889. This report of the Commission was handed to Mayor Chapin of that city, December 23rd, and is published in full below. The members of the Commission were Prof. George W. Plympton, Rossiter W. Raymond and John Reynolds, and these three gentlemen composed an intelligent, industrious and broad-gauged board whose work was creditable and practicable.

THE REPORT.

Hon. ALFRED C. CHAPIN, Mayor of Brooklyn:

Dear Sir,—The Board of Commissioners of Electrical Subways for the City of Brooklyn has the honour to submit the following final report of its work:—

The aggregate length of conductors underground has been increased during the eleven months ending October 31st, 1889, about 839 miles. The length of telephone cable attached to the elevated railway structure during the same period is about seven miles, carrying 644 miles of conductors. The total mileage of conductors now underground in the city (apart from city wires) is 3,007 miles; on the elevated railways (apart from electric light wires), 768 miles. The aggregate thus removed from house-tops and poles is larger than the total of aerial telegraph and telephone wires existing in the city in 1885, when this board was organised.

During the eleven months, 1,418 miles of additional conduits, mostly short connections, carrying 7,862 miles of ducts, and having a capacity of 786 miles of conductors, have been constructed. The telephone company has removed 71 poles, making the aggregate number of poles removed (not including those removed this year by the electric light companies, from which no report has been received), 445. And the telephone wires have been removed from 271 poles, which are still standing, because they carry city wires. The total number of poles which would have been removed by this time if the necessary co-operation of the city had not been delayed, is 677.

For details of the work, reference is made to the appended reports of the different companies.

Permits have been granted by the city, upon the approval of the board, for the following additional conduits:

	Feet.
On Atlantic Avenue, from 16, Smith Street to Flatbush Avenue	3,200
On Third Avenue, from Atlantic Avenue to Sixteenth Street	6,600
On Sixteenth Street, from Fifth Avenue to Hamilton Avenue	2,075
On Bush Street, from Hamilton Avenue to Dwight Street	2,900
On Sullivan Street, from Dwight Street to Ferris Street	1,200
On Flatbush Avenue, from Fifth Avenue (around plaza) to Ninth Avenue	3,600
On Waverley Avenue, from Fulton Street to Myrtle Avenue	3,200
On Grand Avenue, from Fulton Street to Lexington Avenue	1,620
On Franklin Avenue, from Fulton Street to B. B. R. R. Depôt (Atlantic Avenue)	750
On Montague Street, from Court Street to Furman Street	2,100
On Hooper Street, from Broadway to Kent Avenue	3,020
On Division Avenue, from Broadway to Kent Avenue	3,600
On Boerum Street, from Broadway to Bushwick Avenue	2,450
On Van Cott Street, from Graham Avenue to Union Avenue	200
On Union Avenue, from Ainslie Street to Van Cott Street	2,640
On Grand Street from Union Avenue to Kent Avenue	4,150
On N. Eighth Street, from Union Avenue to Kent Avenue	3,020
Total...	46,375

or 8·77 miles, having the capacity to receive 3,500 miles of wire.

These additional conduits represent mainly the extension of the subway system into those remoter parts of the city which cannot be reached by cables attached to the elevated railways, and which, through the rapid increase of the number of telephone subscribers, can now be served to a large extent by trunk cables with terminal distributing lines.

The application of the telephone company for the following further additional routes has been approved by the board, but permits have not yet been granted for its construction by the city

* New York *Electrical Review*.

authorities. The list therefore represents work which the company stands ready to do, if permitted.

	Feet.
On Smith Street, from 16, Smith Street to Hamilton Avenue	5,800
On Sackett Street, from Smith Street to Hamilton Avenue	3,600
On Hamilton Avenue, from Sixteenth Street to Hamilton Ferry	6,400
On Union Street, from Third Avenue to Ninth Avenue ...	4,340
On Jay Street, from Myrtle Avenue to John Street ...	3,400
On Main Street, from Front Street to Water Street ...	300
On Water Street, from Main Street to Fulton Street ...	1,200
On Brooklyn Avenue, from Fulton Street to De Graw Street	3,020
On Bedford Avenue, from Fulton Street to Myrtle Street	4,525
On Throop Avenue, from Halsey Street to Thornton Street	5,920
On Thornton Street, from Throop Avenue to Broadway ...	300
On Flushing Avenue, from Grand Avenue to Washington Avenue	750
On Graham Avenue, from Boerum Street to Van Cott Avenue	5,660
On Van Cott Avenue, from Graham Avenue to Union Avenue	1,500
On Manhattan Avenue, from Van Cott Avenue to Newtown Creek	5,850
On Greenpoint Avenue, from Manhattan Avenue to West Street	1,320
Total	53,885

or 10·2 miles, with a minimum capacity of 4,000 miles of wire.

The Citizens' Electric Illuminating Company and the Municipal Electric Light Company, which divide the city between them on the line of Flushing Avenue and Broadway, reported (as an act of courtesy) December 1st, 1888, a total of 130 miles of wire for both companies, of which 50 miles was attached to the elevated railway. The Citizens' Illuminating Company only has reported its operations for the present year; and, according to its report, it has added about 18 miles of wire to the railway structure, and has increased its pole lines to 120 miles. From the detailed survey of the inspector of the board, a copy of which is annexed, it appears that the present mileage of the companies is as follows:—

Citizens' Electric Illuminating Company ...	215·4 miles.
Municipal Electric Light Company	125·6 „
Total	341·0 „

of which the former company has 78·6 miles of "black" or good insulation, and 136·8 miles of "white" or poor insulation (so-called underwriters' wire), while the latter has 27·7 miles of "black" and 97·9 miles of "white." Unfortunately this board has no authority to control the installations of these companies, or interfere with their operations in any way, for the reason which has been stated in former reports, but which will now be stated again. The Act of June, 1885, makes it the duty of the board, in default of the proposal of plans by the electrical companies themselves, "to cause to be devised and made ready for use" an underground system, and compel all companies "to use such subway so prepared." But it does not furnish authority or means for the construction of such a subway, or means for the compulsion of companies.* And it makes even the choice of a system impossible by annexing the condition that "it shall be the duty of the board in devising the aforesaid plan, so to devise the same that the subway may be used by any such city for the electric wires or conductors operated by its police, fire or other departments without expense, except the expense of the wires or conductors." This command to devise a common subway for all classes of conductors defeats its own object. The electric light wires should never be permitted in the same conduit with telegraph and telephone wires. What the board had hoped to do has been to find a system for a separate high tension subway which it could approve as feasible and safe, and then to obtain from the Legislature a release from the absurd condition it has imposed, and the means to compel the construction and use of such a subway, not by "all companies," but by such companies as ought to use it. This object not having been accomplished, the board was entirely powerless as regarded the electric light companies; for the Act gave it no jurisdiction over aerial wires, until it should be prepared (in the impossible way just described) to compel them to be put underground.

By the letter of the counsel of the board, appended to this report, it will appear that the failure of the Legislature to provide for the continuance in any form of the powers of the board, leaves in force the Act of 1884, as amended by that of 1885; that there is now no power in any department to grant permits for overhead wires, and that it is still the duty of the city authorities to remove all such wires for which permits have not been granted with the approval of this board. While it is not suggested that the wholesale destruction of property should be entered upon by the city in obedience to the literal requirement of the law, it is believed that this situation, which puts the electric light companies in particular at the mercy of the city, may be fairly utilised to compel those companies to improve their methods and plant, and the report of the inspector of the board is appended for the purpose of indicating how great an impoovement is possible.

In looking back upon the difficulties and labours of four years, the board is satisfied that as much has been accomplished as was practicable under the terms of the Act, and it fairly claims the credit of having taken no step which it has been obliged to retrace—a result, whether due to wisdom or good fortune, which must be considered remarkable, in view of the uncertainties surrounding the problem attacked, and the hostile influences at work to hinder its solution.

A review of the policy pursued by the board, together with some suggestion based upon its study and experience of the subject, with regard to wiser legislation, may fitly conclude this report, and with it the service which the members of the board have to the best of their ability, and at some personal sacrifice, attempted to perform for the city of Brooklyn.

The Policy of the Board.

In view of the inconsistency, inadequacy, and partial absurdity of the law, the question might be asked, how citizens with reputations to lose could consent to administer it? The notion that the acceptance of such an office implied the admission that its nominal duties were all practicable was not, indeed, entertained by the Commissioners; but it was seriously doubted by them, at first, whether they could accomplish enough under the Act to warrant them in undertaking the task. It was, however, urged upon them by the Mayor that the law, however defective, had been enacted in good faith, and would undoubtedly be amended as necessity should be shown; that its spirit was to confer upon the board certain discretionary powers, in the exercise of which some public good might be secured; that it was better to do what could be done than to do nothing at all, while waiting for wiser legislation; and, finally, that if the board should receive from any electrical company within the 60 days prescribed by the law a practicable subway plan, the duties and powers of the board as to that company (and others capable of using that plan) would be clear and useful, even though its hands might still be tied by the law itself as against all other companies.

The board accordingly organised itself according to the law, and in due time the New York and New Jersey Telephone Company, operating nearly all the telephone wires within the city limits, presented with the concurrence of the Western Union Telegraph Company, a plan of subway construction which, after examination and some modifications, was approved by the board. If this plan had not been proposed, the commissioners could have accomplished nothing whatever under the Act as it stood. The experience of the similar board in New York City confirms this opinion. That board receiving no plan from the electrical companies, tried to act under the alternative provisions of the law; and everything which it did was subsequently pronounced illegal; so that its work could only be rescued and continued by its reorganisation with wider powers, and the legalisation by special statute of its former acts. No such legislative assistance has been rendered to the Brooklyn Board. What it has modestly asked in that line has been invariably refused; and whatever it has accomplished has been done under the Act of 1885, with all its defects.

To understand the situation created by the proposal of the telephone and telegraph companies, it should be considered that there were in Brooklyn at that time (apart from the city wires) 4,659 miles of aerial conductors,* of which 4,600 miles carried low tension currents for telegraph or telephone; that of these 4,600 miles, 4,192 miles were owned or controlled by the companies agreeing to employ the said conduit; that 138 miles were owned by the Baltimore and Ohio Telegraph Company, which could use such a conduit; that 271 miles were owned by district telephone companies, carried upon house-tops, not upon poles, and not practicably to be combined in any conduit, while their extent remained so small and their distribution so scattered; and, finally, that the high tension electric light conductors amounted to but 59 miles in the whole city.

Obviously, therefore, the approval by the Board of the system proposed by the telephone and telegraph companies would give it the right of inspection and control over nearly 99 per cent. of the existing electrical conductors; and if the problem presented by these could be successfully treated, *without hindering the future solution of the whole problem, comprising the disposition of all classes of electrical conductors*, the commissioners felt abundantly justified in attempting it. They anticipated (and in this anticipation they have not been disappointed) collisions with political and private interests, malicious misrepresentations and honest misunderstandings of their action; but they believed that they could accomplish for the city something worth doing, and not needing to be undone. The result has justified this belief.

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* The board is not made by the act capable of suing or being sued—a defect which, though overlooked in cases in which the board has appeared as defendant, would have proved fatal if it had proceeded as plaintiff. The attempt of the board to have it cured by additional legistation was defended.

* The law does not require a company constructing its own system upon its own plan to leave room in it for city wires; but this was done voluntarily by the Telephone Company at the suggestion of the board. The board, however, has had no power to oblige the city to use such conduits; and the police and fire departments prefer in most cases to construct separate subways.

The statement compiled from June, 1886, when the work of putting conductors underground practically began, is here followed, fractions being disregarded.

In approving the box conduit of creosoted wood, described in former reports, the board had to consider, first, the practicability and safety of this system taken by itself; secondly, its relation to the public convenience, and to the desired reform of the nuisance of overhead wires; thirdly, its relation to the general problem, comprehending *all* electrical conductors.

Under the first head, the suitability of the material, ease and cheapness of construction, facility of laying and replacing or repairing conductors, and dangers from lighting or from gas-explosions, required examination.

Under the second head, the amount of disturbance to pavements involved in construction and maintenance; the extent to which poles and overhead wires could be superseded by the system; the degree of ease with which it could be progressively extended, without interrupting its operation; and the rapidity with which connections could be made or changed, received consideration.

Under the third head, the important question arose whether the adoption of this system would prevent the subsequent establishment of underground systems for high tension conductors.

At a number of public sessions, the board listened to the statements and examined the drawings and models of inventors, besides studying in private the records of experience in other places. But neither at that nor at any subsequent time did it find reason to doubt the wisdom of its decision in favour of the box-conduit of creosoted wood, carrying lead-covered cables and connected with overhead terminal distributing system, for telephone and telegraph wires.

As to the material, it has proved entirely satisfactory, when properly prepared; and is superior in one or more particulars to any other that has been proposed. Of its great durability there is no question. Its elasticity makes it better than any concrete or terra-cotta. It does not tear the lead upon the cables drawn into it, as both concrete and iron are likely to do; it permits a construction leaving no joints liable to sag and open by their own weight and under pressure.

At to the form, it is easily constructed and laid by ordinary workmen, permits the easy passage of cables, successfully resists all surface-pressures, presents a large capacity in moderate space, can be readily constructed to suit any capacity, and is in other respects as good as any form hitherto proposed.

Competitive trials of other materials and forms permitted by this board, and the use of such other conduits elsewhere, have not shown anything else to be better for the purpose named, and for the conditions existing in this city.

Furthermore—and this the board could not but regard as most fortunate—the system was not covered by patents and could therefore be freely used by all companies. If it had been radically defective in any particular, and any patented device presented to the board had offered a satisfactory and necessary remedy for such defect, the board would have felt bound to make its approval conditional upon the employment of the device. But this contingency did not arise; and with regard to its telegraph and telephone subways, Brooklyn is to-day not at the mercy of any patent, covering either material or form.

On the other hand, it was urged against this conduit by the advocates of other types, that it was not gas-tight or water-tight, and that it was not itself an insulator. These assertions are all true, but the conclusive answer is, that it is not practicable to make a subway perfectly and permanently tight, or practically insulating, and hence money spent in that direction is thrown away. The protection and insulation of the conductors must be separately provided for; and for low-tension currents, this is satisfactorily done by enclosing the insulated wires in lead pipes.

Upon the subject of gas explosions the board, in its first report, made September 15th, 1885, observed:

"The objection to box-conduits, that they may give opportunity for the accumulation of explosive mixtures through leakage from the gas-pipes, has been duly considered, and the board believes that effective provision can be made for the prevention of such accumulation in this condition."

This provision was made and has proved effective. The frequent occurrence of such explosions in other cities has directed public attention to this source of danger, the elements of which are by no means absent in Brooklyn, and the significant absence of such occurrences in this city is directly due to the features of the Brooklyn subway system. Gas mains will leak. It is useless to forbid that; and to hold the gas companies responsible, as has been proposed, for the consequence of such leakage would be in many cases unjust, and would in all cases lead to intolerable public inconvenience in the perpetual disturbance of the streets for repairs. Especially when, by the reckless inclusion of gas main joints in a conduit or manhole of later construction, the leakage has been invited, the responsibility of its consequences can scarcely be upon the company which laid the main originally in a proper way, and did not provide for its subsequent exposure and the suspension of the joint in air, or its subjection to variations of temperature.

In many instances the serious explosions in subway manholes have been traced to such exposed and strained joints, improperly included in the subway system. Against the rush of gas from such a large leak, perhaps no artificial ventilation would be an adequate protection. The obvious remedy for such a danger is to have no gas main joints included in the subway excavations.

But, apart from this preventable peril, the soil under all streets where gas mains have existed for any considerable period is more or less saturated with gas, which may find its way into any adjoining spaces. This consideration should prevent the direct connection of open subways with the cellars of buildings. On sanitary grounds alone such a connection is to be condemned. If house connections are underground they should not be made through pipes or open conduits.

Another objection to such connections is that they interfere with the proper ventilation of the subways. A building 60 feet or more in height, and often filled with warm air, will counteract any puny, cheap chimney that may be set up to oppose its action.

(To be continued.)

ELECTRIC LIGHTING AT BRIGHTON.

A REPORT embodying important proposals with regard to the future lighting of Brighton has just been prepared by the Lighting Committee for presentation to the Corporation. At the present time the "queen of watering places" is supplied with the electric light by the Brighton Electric Lighting Company, which is now applying to the Board of Trade for further powers. It is proposed by the Committee that the Corporation should oppose this application and undertake the supply of the electric light themselves.

The report commences with an outline of the preliminary negotiations, when a deputation representing the Corporation had an interview with Mr. Courtenay Boyle and Major Cardew, representing the Board of Trade, and urged upon them the advisableness of permitting the present arrangements of the Electric Lighting Company to remain undisturbed until such time as the Corporation were ready to supply the light under their order. The reply of the board was that they had informed the Brighton Electric Light Company that they must reconstruct their lines within three months, in accordance with the department's requirements, and that the effect of yielding to the council's requests would be that the existing dangerous condition of the supply, which has been pointed out by one of the Board of Trade inspectors, would be continued for a longer period than the board contemplated to be necessary for the reconstruction of their system. But as the Town Council were fully aware of all the circumstances of the case, they would defer to their wishes, at the same time pointing out that they incur a grave responsibility by allowing the present dangerous condition to remain longer than was absolutely necessary. The Lighting Committee's report then deals with the powers of the Corporation which have not hitherto been exercised, in consequence of the uncertainty surrounding the question, and the fear that works established with the view of adopting any particular system of supply would, within a short period, become useless by the invention of more suitable machinery and appliances, or the discovery of more economical means of supplying electricity, and states that when the Corporation successfully opposed the Brighton Electric Light Company's application to the Board of Trade in 1889 it was understood by the authorities that the council would themselves supply the light within two years. With the view of redeeming that promise, the committee have been in consultation with Mr. Shoolbred, C.E., the electrical engineer to the Bradford Corporation, who has presented a long report on the subject. He states that in 1883 Brighton was one of the few towns to consider it advisable in the interest of their ratepayers to obtain powers for themselves for the supply of electricity over its municipal area. Many large towns are this year applying for electric lighting powers, and the chief reason for this very marked alteration in the opinion of local bodies seems to be that they consider it would be highly prejudicial to the interests of their own ratepayers to allow a body of individuals, trading for their own profit, and in many cases foreign to the town, to become for a period of years the masters of the local authority, who would eventually have to purchase back from the traders their own rights over the town at a considerable cost to the ratepayers. There were two courses for a town like Brighton to adopt, in case the Corporation decided to carry out the provisions of its own order. One course was to keep under its control the whole of the electric lighting arrangements, and the other was to place it out to contract with some company or firm for a certain term and subject to certain conditions. In both cases there would have to be an outlay, but in the latter case there would also be a considerable amount of risk. With reference to the best mode of supply, Mr. Shoolbred expresses an opinion, that the continuous current and accumulators are most effective and economical. The best sites for the generating stations would be at the Park Street depôt, and in the neighbourhood of Queen's Road. These stations would, if desired, help each other. The Corporation might extend the area of supply and take in some of the large streets, not mentioned in the authorisation. The entire distributing system should be upon "low pressure," as required by the Board of Trade, in the houses themselves, not merely in the interests of general safety, but also to inspire public confidence in freedom from danger. The stations should be as compact as possible, especially in the centre of the town where land is dear. Inverted-vertical triple expansion engines, working at about 200lbs. boiler pressure, and driving each its dynamo direct, would best comply with the above conditions. In order to secure that these engines and dynamos should work under favourable and economical conditions, it might be desirable to make some difference in the size and output of these engines, in order to meet the varying demands of the supply. Similarly, in order to ensure due efficiency in the boilers, both as regards general economy in

steam production, and as to rapidity in so doing (when required), it is probable that more than one type of boiler would have to be erected. The Cornish or the Lancashire boiler possesses certain advantages in certain condition, over the tubulous boiler and *vice versa*. Mild steel should be employed in the construction of these boilers, where possible. The design and construction of the requisite buildings at the station should be such as not merely to be adapted to the site itself, but also to be suited, without much alteration, to a more extended supply, the more especially as the conditions of a proper supply to the town would not admit of any interruption taking place in that supply in order to allow of reconstruction. With regard to the question of expenditure, the cost of supplying that portion of Brighton between the east side of Old Steine and the western boundary of the municipal borough, bounded on the north by Church Street, Upper North Street, and Montpelier Terrace, would be £30,000. This expenditure would allow of an installation of 10,000 16-C.P. lamps, with a maximum of 50 per cent. in use at one time. This outlay would be distributed in the following manner:—Buildings, £3,000; boilers, £2,800; engines, £2,400; dynamos, £2,800; instruments, £800; mains and distributing service, £9,600; storage batteries, £5,500; meters, house services, and contingencies, £3,100—total, £30,000. The supply would be in force the whole 24 hours, since storage batteries are included in order to carry on the supply during the late hours of the night and of the early morning, when the demand has become so small as to make it desirable to stop the engines and thus diminish the hours of working at the station. Although the provisional order allows a charge of 7d. per Board of Trade unit, Mr. Shoolbred does not deem it advisable to make the price higher than 6d. per unit. The committee recommend that the Corporation should take over the electric lighting powers conferred upon them by the Board of Trade in 1883, and that the necessary plant and machinery should be obtained for the purpose; that the continuous current system at low pressure, combined with storage batteries, should be employed; that a district, lying between the eastern side of the Old Steine on the east, the western boundary of the borough on the west, the southern boundary of the borough on the south, and Montpelier Place, Montpelier Terrace, Upper North Street, and Church Street on the north, the houses on both sides of such streets being included, should comprise the area; that the works should be established at a cost of £30,000, and that the Town Clerk should apply to the Board of Trade for permission to borrow the sum on the security of the general district rates, repayable within a period of 40 years; that the charge per unit should be 6d.; and that the committee should be authorised to select sites and to make all the necessary arrangements for the carrying out of the work. The committee also report that Mr. Shoolbred is willing to undertake, design, superintend, control, and be responsible for the work of installation, with the aid of a clerk of works to be appointed by him and paid by the Corporation, subject to certain conditions as to commissions, &c., and they recommend that he should be appointed electrical engineer to the Corporation. The General Purposes Committee advise the council to refuse their consent to an application for a provisional order by the Brighton Electric Light Company.

PROCEEDINGS OF SOCIETIES.

Physical Society, January 17th, 1890.

Prof. W. G. ADAMS, Vice-President, in the chair.

OWING to the unavoidable absence of Mr. F. B. Hawes, his paper on "A Carbon Deposit in a Blake Telephone Transmitter" was postponed.

Dr. S. P. THOMPSON made a communication "On Electric Splashes," and illustrated his subject by beautiful experiments, on the production of Lichtenberg's figures. The author has recently investigated these phenomena as modified by varying the conditions under which the figures are obtained, and has arrived at the following conclusions:—1. The nature of the dielectric plate does not change the character of the figures produced, and 2, the nature of the powders used seems to have no material effect on their shape. In the course of his experiments he has found a mixture of sublimed sulphur and lycopodium to give better figures than the red lead and sulphur usually employed, and also that a large and highly polished knob is advantageous, particular when the Leyden jar is charged negatively. Sometimes when obtaining negative figures, nebulous patches occur, and these were attributed to the so-called electric winds sent off from roughnesses on the knob when not sufficiently well polished. If instead of bringing the knob in contact with the plate, it is only brought near to it, then a peculiar figure closely resembling a "splash" results. A positive splash consists of short lines radiating from the point of approach, whilst a negative splash is made up of more or less rounded spots, which become elongated in a radial direction as their distance from the centre of the splash increases. Negative splashes are, however, much more difficult to produce than positive ones.

When viewed in the dark, the discharge producing the splash is seen to consist of a bundle of small sparks which branch outwards on approaching the plate. In conclusion, the author remarked that roughnesses on a conductor produced more electric winds when the conductor is charged negatively than when positively charged, and invited the opinions of members as to the causes of the differences observed between positive and negative electricity.

Prof. Rücker said he had recently obtained figures produced by discharges on photograhic plates. Generally, he observed, that negative discharges produced roundish patches, whilst positive ones gave more filamentary figures. On passing a spark across a glass plate covered with lampblack, its trace was found to have a black core at one end whilst the other was quite clear. He also made remarks on the distinctive character of the positive and negative discharges in partial vacuo, and considered investigations as to the causes of such differences to be of great importance.

Prof. ADAMS thought any attempt to discover the causes of such differences as those noted in the paper, was to be commended, for the well-known fact that it is more difficult to insulate a negative charge than a positive one has long needed an explanation.

A paper "On Galvanometers," by Prof. W. E. AYRTON, F.R.S., T. MATHER, and W. E. SUMPNER, D.Sc., was read by Prof. AYRTON. In fitting up the Physical Laboratories of the Central Institution of the City and Guilds of London Institute, the authors have had occasion to obtain galvanometers of various types and patterns, some of which have been made to special designs, and specimens of instruments embodying recent improvements were exhibited at the meeting.

The question as to whether fairly sensitive galvanometers should be astatic or non-astatic was answered in favour of the former system, from the fact of its being less affected by external magnetic disturbances, and the greater ease with which great sensibility may be obtained.

The usual method of placing the mirror inside the coil was shown to be undesirable, and in the newer forms of instruments, Mudford's improvement of placing the mirror outside the coils has been adopted, the space near the axis of the coil being nearly filled with wire. It was also shown that if wire be wound in a certain approximately spheroidal space near the magnets, then these convolutions will tend to oppose the more distant portions of the coil; however, by winding the two parts in opposite directions, they conspire to deflect the magnet.

Details as to methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges, or otherwise, so as to be readily removable, was pointed out.

A galvanometer devised for teaching purposes, and provided with variable damping arrangements, was described, in which the damping is effected by enclosing the mirror in a glass cell, whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable, both as an ordinary damped galvanometer or as a fairly ballistic one.

In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping; this correcting factor is simple enough when the damping is small, but becomes more complicated as the damping increases, and to facilitate the calculations a table of values of the factor for various values of λ (the logarithmic decrement) has been calculated. From this it appears that for values of λ less than 0·5 the value of the factor is very nearly $(1 + \frac{1}{4}\lambda)$, the correction usually employed.

Improvements in methods of insulating the coils and terminals of galvanometers required for insulation tests were next described, the principle of which may be gathered from figs. 107, 108, in Prof. Ayrton's "Practical Electricity." A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils to the base of the instrument is between 30 and 40 inches of ebonite artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods which depend from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing and specification by Messrs. Nalder Brothers, but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford.

With reference to the proportionality of deflection to current in reflecting galvanometers, it was pointed out that ordinary instruments may differ as much as 2 per cent. within the limits of the scale, hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the d'Arsonval type sometimes differ from proportionality quite as much as the one above referred to, but by fitting such instruments with curved pole pieces, and allowing the coil to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30 inches long.

Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figures of merit" of various instruments to the same standard, in comparing their sensibilities. The standard adopted as most convenient and closely approximating to practical usage is arrived at by supposing the distance of the mirror from the scale to be equal to 2,000 scale divisions, and the sensibilities for current and quantity are given as *scale divisions per micro-ampère* and *scale divisions per micro-coulomb* respectively. The period of oscillation is also taken into account.

A table showing the resistances, sensibilities, coefficients of self-induction, and volumes of the coils of various instruments, together

with the relations existing between them, accompanies the paper, and from this it appears that in the best astatic double coil instruments of from 10,000 to 30,000 ohms resistance the number of scale divisions per micro-ampère may reach 400 times the resistance to the $\frac{3}{5}$th power ($400\ R^{\frac{3}{5}}$), when the period is 10 seconds.

In obtaining data of various instruments the authors have consulted, amongst others, Prof. Threlfall's paper on the "Measurement of High Specific Resistances," in the *Phil. Mag.* for December, 1889, and noticed two serious errors. The first of these makes an instrument constructed according to Messrs. Gray's pattern, nine times less resistance than it actually was, whilst the sensibility of a form recommended in the paper is given as 17 times too great.

On account of the lateness of the hour, the discussion was adjourned till February 6th, before which time it is hoped that a fairly full abstract will appear in the technical papers.

NEW PATENTS—1890.

232. "Improvements in electric motors and dynamo-electric machines." J. HOPKINSON, E. HOPKINSON and G. A. GRINDLE. Dated January 6.

241. "An improvement in telephone switchboards." A. WHALLEY. Dated January 7.

261. "Improved electric truss." G. T. RICK and W. R. KING. Dated January 7.

272. "Improvements in electro-magnetic despatch apparatus." R. HADDAN. (Communicated by J. T. Williams, United States.) Dated January 7. (*Complete.*)

274. "Improvements in electric bells." A. NATTERER. Dated January 7.

303. "Improvements relating to secondary batteries." H. H. LAKE. (Communicated by P. H. Alexander, United States.) Dated January 7. (*Complete.*)

350. "Improvements in the formation of electrodes for use in primary and secondary electric batteries." L. EPSTEIN. Dated January 8.

402. "Improvements in or connected with electric clocks." F. A. GRAF. (Communicated by D. H. Nahler, Switzerland.) Dated January 9.

425. "Improvements in the construction and laying down of high potential electric mains." J. C. RICHARDSON and H. MOON. Dated January 9.

475. "Improvements in or connected with apparatus for telegraphic and telephonic communication." J. SACK and VON MALTITZ and ZIESEL. Dated January 10.

488. "Improvements in and connected with primary batteries." M. SAPPEY. Dated January 10.

534. "Improvements in electrical switches." G. BINSWANGER and H. J. COATES. Dated January 11.

600. "Improvements in the manufacture of brushes for dynamo-electric machines." J. C. MEWBURN. (Communicated by H. Carrière, France.) Dated January 13.

607. "Improvements in or connected with engines, vehicles, or machines driven by electric motors." R. PEACOCK and H. L. LANGE. Dated January 13.

615. "Improvements relating to electric circuits for lighting and other purposes, and to devices for controlling the flow of the current therein." R. B. EVERED and T. RUDLING. Dated January 13.

665. "Improvements in or relating to reversible electric motors." P. J. R. CRAMPTON. Dated January 14.

693. "Electric motors." S. C. C. CURRIE. Dated January 14. (*Complete.*)

695. "Improvements in the manufacture of light emitters or illuminants for electric and other lamps." J. CLEGG. Dated January 14.

696. "Improvements in the manufacture of light emitters or illuminants for electric and other lamps." J. CLEGG. Dated January 14.

718. "Improvements in electric lamp couplers or holders." A. E. NICHOLS. Dated January 15.

761. "Process of generating electricity by gas batteries." O. DAHL. Dated January 15. (*Complete.*) [Date applied for under Patents Act, 1883, Sec. 103, June 17th, 1889, being date of application in United States.]

771. "Improvements in and connected with telephone systems." W. OESTERREICH and W. GENEST. Dated January 15.

847. "Improvements in and relating to electrical communicators for use on travelling vehicles." C. GRAHAM and F. ALLEN. Dated January 16.

872. "A dynamo machine for alternating currents." J. PERRY. Dated January 17.

873. "Improvements in electric supply meters." J. PERRY. Dated January 17.

878. "Improvements in and connected with dynamo machines for producing electric energy, ventilation of culverts for distributing it, accumulators for storing it, and motors for utilising it." J. SWINBURNE. Dated January 17.

941. "Improvements relating to electric tramways and tramcars." A. L. LINEFF and E. H. BAILEY. Dated January 18. (*Complete.*)

962. Improvements connected with cars worked by electric accumulators." J. SWINBURNE. Dated January 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

16623. "Improvements in electricity meters." LAURENCE, PARIS and SCOTT. Dated November 15. 8d. Consists of a time keeper which at stated intervals completes an electric circuit which causes the operation of a recorder to an extent in accordance with the quantity of current being used at that particular time. The current which passes through the circuit thus completed also causes the circuit completing device to break the circuit to again complete it at the end of the next succeeding interval of time and so on. 6 claims.

16946. "Improvements in fittings and switches for incandescent electric lamps." J. Y. JOHNSON. Dated November 21. 8d. Relates to the fittings by which the bulbs of incandescent lamps are detachably connected to the chandelier bracket or the like with which they are used. It relates mainly to those fittings in which vitrite or other insulating material is used in combination with metal. 5 claims.

17155. "Improvements in electrical spring switches." E. W. LANCASTER. Dated November 26. 8d. Relates to an improved electrical switch constructed to fly off, or on and off, by means of a spring, so as to give a quick and reliable make or break for any electrical circuit. 3 claims.

17178. "Improvements in electric motors." W. M. MORDEY. Dated November 26. 6d. Claim:—In an alternate current motor, the construction comprising a series of magnetising or field windings, a portion or portions of which are traversed by an alternate current from an external source, while another portion, or other portions, is or are traversed by an alternating current obtained from the armature, with or without the interposition of an impedance coil, substantially as described.

17795. "An improvement in electrical arc lamps." J. BROCKIE. Dated December 6. 8d. Relates to a construction and arrangement of automatic clutch apparatus for raising or lowering the upper carbon of an electrical arc lamp. The inventor passes the carbon or its holder through a sleeve through which it is free to slide, this sleeve being somewhat heavy or urged downwards by a spring. At one side of the sleeve is pivotted a horizontal lever having a tongue projecting down from it towards the carbon. One end of this lever is linked by a connecting rod to the core of a regulating solenoid or to the armature of a regulating electro-magnet, the other end of the lever, namely that which is on the same side of the carbon as the tongue, rests upon a prop or is suspended freely by a slotted link. When the connecting rod is raised by the action of the solenoid or electro-magnet, the lever becomes canted so that its tongue is pressed hard against the carbon or its holder, holding it as a clutch, and by the farther ascent of the connecting rod the sleeve and carbon are raised together. When the connecting rod descends, the lever on reaching the prop or the end of its suspending slot, becomes canted back, releasing the carbon or its holder from the pressure of its tongue and thus leaving the carbon free to descend in the sleeve. 1 claim.

18035. "Electro-static apparatus for measuring potentials." SIR WILLIAM THOMSON. Dated December 11. 11d. The inventor uses an electro-static arrangement of which the part whose potential differs most from the earth is a smooth insulated conductor, which may be of a cellular or multicellular form. The movable body may be a metal plate or an arm or a group of metal plates or vanes. The electro-static force acting upon the movable body may be equilibrated by torsion, or by torsion and gravity, as in the well-known bifilar balance; or by gravity as in an ordinary balance; and may be read by inspection on a scale, or may be determined by a balancing operation. For checking the vibrations of the index, the inventor uses a rigid or elastic piece of solid material which may be brought momentarily and gently to touch upon the index itself or other connected moving part of the apparatus. To prevent all other motion of the checker than the one desired motion, he mounts it on a geometrical slide. 4 claims.

1889.

12418. "Improvements in or relating to the manufacture of insulating tubing for electric conducting wires." A. J. BOULT. Dated August 6. 8d. (A communication from H. B. Cobb, of America). Relates to the practice of a process and to the lead-press employed therein for providing, in an expeditious, simple and comparatively inexpensive manner metal-coated insulating tubing for electric conducting-wires, which tubing shall serve as

a means of affording a high degree of insulation to the wire, and of effectually grounding induced currents, and which may, after undergoing the process of its formation afford an equally effective means of insulation by stripping it of its metallic casing, and thus adapt it for use where the metallic casing is not required. 9 claims.

12615. "Improvements in and relating to dynamo-electric machines or motors." F. J. PATTEN. Dated August 9. 8d. Consists mainly in a novel method of operating electric motors on alternating current circuits, the principal object being to produce an operative self-starting alternating current motor by a simple modification of the armature connections of a direct current machine of the Gramme type. 8 claims.

CORRESPONDENCE.

Single Coil Reflecting Astatic Galvanometer.

Enclosed is a sketch showing an improvement in reflecting astatic galvanometers, which I have lately applied with great success.

The advantages of the astatic system of needles are obtained at about one-quarter of the usual expense in manufacture by employing one bobbin of wire instead of four.

Reference to the sketch will show how I arrange the magnets and mirror, and a very few words in explanation will be sufficient.

In fig. I, which is a part section through a galvanometer, "A" is the bobbin wound with a large number of turns of fine wire, and one layer of thick wire.

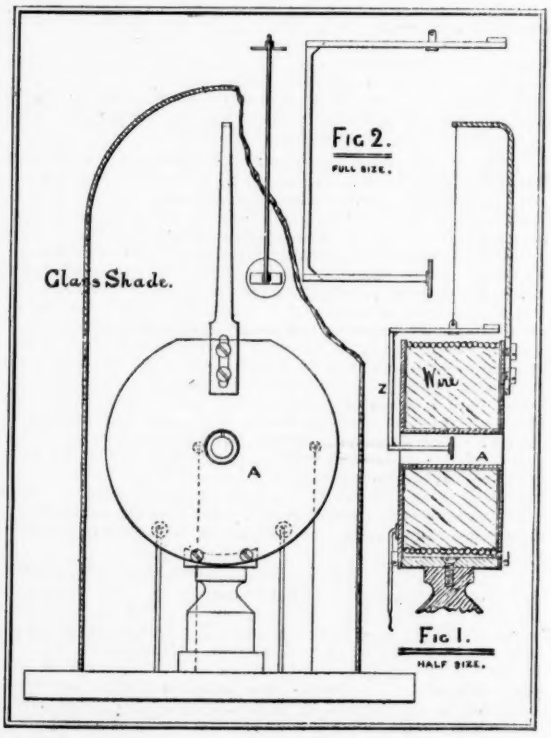

FIG 2.
FULL SIZE.

FIG 1.
HALF SIZE.

The bobbin is supported by an ebonite foot, and the ends of the wire coils are brought down through the ebonite base to four terminals.

The connecting shaft of the needles is shaped as shown in fig. 2.

This shaft is built up of match-box wood, in slips about $\frac{1}{64}$-inch thick by $\frac{1}{16}$-inch wide, soaked in shellac varnish and dried under pressure, to keep them quite flat.

Two horizontal arms are cemented to the vertical piece, *z*, at top and at bottom.

To the bottom pair a needle of watch mainspring is cemented, and the mirror is attached to the needle by thick shellac varnish.

The top arms have an eyelet cemented between them for the suspension fibre, and beyond the eyelet is a very small weight, just enough to counterbalance the wooden rods.

The top magnet is cemented below the eyelet.

The suspension fibre is carried by a brass arm on the side of the bobbin, the height being adjustable.

It will be evident that a fibre of any desired length may be used, and the needles can be easily replaced if the fibre gives way.

The periodic swing of the needles being very slow, I find that the thick wire coil comes in conveniently for stopping the excursions of the spot of light.

By making them up in circuit with a Daniell's cell and a tapper key, the spot can be brought back to its zero position almost instantly.

For marine work, where the line of support of the needles must pass through their common centre of gravity, the frame can be shaped like an E, and held by a fibre at top and bottom.

With the E-shaped frame three needles may be used with advantage, one on each arm, arranged N — S, S — N, N — S, but a directive magnet must be used.

W. R. Wynne.

Munro and Jamieson's Pocket-Book.

As no one has replied to Prof. Jamieson's letter, in which he asked for a more reliable rule for determining the voltage of "unmarked" incandescent lamps than that suggested by "Ajax" and given in the Pocket-Book, I venture to give the following:—In the absence of proper photometrical testing apparatus the best thing to do is to run a known lamp at its proper voltage, and to gradually run up the unknown lamp until it appears by eye to be equally bright, and then note the volts at its terminals. This will be the voltage required. The candle-power can also be determined if the current in each case is observed. The C.P. of the unknown lamp will bear the same ratio to that of the standard lamp, as the watts absorbed by the unknown lamp bear to the watts absorbed by the standard, as both lamps will be running at the same efficiency or watts per C.P.

Many people seem to find a difficulty in realising that when two lamps are equally bright they need not be giving the same amount of light; or that when one lamp is brighter, *i.e.*, gives a white light, and consequently is at a higher temperature and efficiency than the other, it may at the same time be gaining a lesser C.P. For instance, a 100-volt 10 C.P. lamp at 3 watts per C.P. will look brighter than a 100-volt 16 C.P. lamp at 4 watts, and, therefore, may appear to the eye to be giving a greater C.P.

I have repeatedly found that one's eye cannot gauge C.P. or quantity of light, but only colour or quality of light, except with very wide differences.

The method suggested by "Ajax," and pronounced by Prof. Jamieson to require too many assumptions for practical men, can hardly give any better result than a guess pure and simple would do; because (1) the ratio of resistance cold to resistance hot must be known. It is usually considered to be constant and = 2; whereas, as a matter of fact, it may vary from 1·6 for an unflashed filament to 2·4 for a similarly made filament when highly flashed; and may vary between even wider limits than those with different varieties of carbon. Thus the cold resistance need not give any indication of the hot resistance whatever. (2) It is impossible by mere inspection of a lamp to estimate the surface area of its filament to within anything approaching the necessary accuracy. (3) Even if (2) was successfully accomplished, the nature of the surface—its emissivity—would be an unknown quantity.

I would not, however, say that this method is entirely useless in all cases. For instance, if two or more lots of lamps of different voltages, *by the same maker*, had got mixed, they might be separated out again either by inspection of the filaments or by measurement of their resistances cold.

G. S. Ram.